APPENDIX A

SAMPLE DATA SHEETS

DC-1

DATA COLLECTION FORM
NATURAL HAZARDS EFFECTS
(Extreme Winds, Earthquakes)

A. GENERAL DATA

*1. Facility No. ________ 2. Building Name ________________________

3. Address ________________________ 4. City ______________

5. State ______________ 6. Zip Code ________ 7. Year Built ________

8. Date of Major Modifications or Additions, if any ________________

9. Building Code Jurisdiction: City ☐ County ☐ State ☐ Federal ☐

*10. Latitude ________________ *11. Longitude ________________

12. Current Bldg. Use ____________ Orig. Bldg. Use ______________

13. Basement Yes ____ No ____ Number of Basements ______________

No. of Stories Above Basement ____________ (See also Item A23)

14. Height of First Story ______________ ft.

15. Upper Story Height ____________ ft. Special Story Height ________ ft.

16. Is the exterior of first story different from upper stories?

Street Front Side Yes ____ No ____ Other Sides Yes ____ No ____

17. Approximate Roof Overhang Distance ____________ Side ______________

18. Proximity to Adjacent Buildings: Sketch Below with North Arrow

North Side _______ South Side _______ East Side _______ West Side _______

Note Street or Alley Sides ________________________________

*To be filled in by Field Supervisor.

Sketch

DC-2

19. Are plans available? ______ If so, where obtainable ____________________

____________________ Are original calculations available? ______ If so,

where obtainable ____

Name of: Architect ____________________ Engineer ____________________

Contractor ____

Regulatory Agency ____

20. Basic Building Plan

a. Sketch overall plan.
b. Locate shear walls, if any.
c. Locate main frames.
d. Locate expansion joints, if any.
e. Give approximate north arrow and label sides "A", "B", "C", "D", etc. Show street or alley sides.
f. Note any common or party walls.
g. If plan changes in upper floors, sketch this plan and note level of change.

(Use additional sheet if necessary)

DC-3

21. Elevation of Exterior Walls.

Sketch:
- a. All openings or note pattern of openings.
- b. Note exterior finish and appendages.
- c. Note material of walls.
- d. Major cracks or other damage. (Note if cracks are larger at one end.)
- e. Note previously repaired damage.
- f. Note any evidence of damage to cladding or appendages.

(Use additional sheet if necessary)

DC-4

22. Elevation of Interior Shear Walls.

Sketch: a. All openings.
b. Major cracks or other damage. (Note if cracks are larger at one end.)
c. Note any previously repaired damage.

DC-5

23. Adaptability of Basement to Storm Shelter.

    a. Floor Over Basement - Concrete ☐ Other ☐

    b. If concrete, give thickness ________

    c. Available Space (approximate) ______________ sq. ft.

    d. Dangerous Contents. Storage of Flammable Liquids ☐

    Presence of Transformers or Other Dangerous Equipment ☐

    Other Hazards ____

    None ☐

24. Is this a Vault-like Structure? Yes ☐ No ☐

DC-6

25. EXTERIOR WALL SUMMARY SHEET

Exterior Characteristics	Side A	Side B	Side C	Side D
Extensive Architectural Ornaments or Veneer				
WALLS Metal Curtain Wall				
Precast Concrete Curtain Wall				
Stone				
Brick				
Concrete Block				
Concrete				
Other				
For Concrete Block and Brick, indicate R for Running Bond S for Stacked Bond				
Condition of Wall*				
OPENINGS Percent of Open Area per Story				

*1. No cracks, good mortar.
2. Few visible cracks.
3. Many cracks
4. Evidence of minor repairs.
5. Evidence of many repairs.

DC-7

B. SITE RELATED INFORMATION

1. Exposure

a. Centers of large city [ ] b. Very rough hilly terrain [ ]

c. Suburban areas, towns, city outskirts, wood areas, or rolling terrain [ ] d. Flat, open country [ ]

e. Flat coastal belts [ ] f. Other [ ]

2. Topography

a. Building on level ground [ ] b. Building on sloping ground [ ]

c. Building located adjacent to embankment [ ]

*3. Geologic formation ____________________

*4. Location of known faults: Name ____________________ Miles ______

____________________ Miles ______

*5. Depth of water table ________ ft. When measured: ____________________
(Month) (Year)

*6. Depth of bedrock ____________ ft.

*7. Soil type ____________________

*8. Bearing capacity ____________ p.s.f., or ____________ blows per inch

9. Proximity to potential wind-blown debris - Type ____________________

Location ____________________ Distance ____________

*To be filled in by Field Supervisor.

DC-8

C. STRUCTURAL SYSTEMS

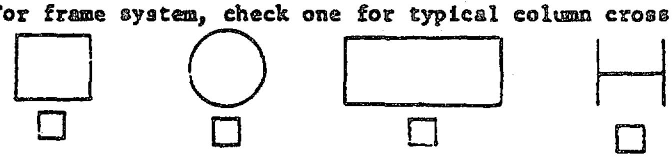
1. Material

Concrete ☐ Masonry ☐ Steel ☐ Wood ☐

2. Vertical Load Resisting System

Frame ☐ Bearing Wall ☐ Wall and Pilasters ☐

For frame system, check one for typical column cross-section



Other ☐

3. Lateral Load Resisting System

Masonry Shear Wall ☐

Concrete Shear Wall ☐

Plywood Shear Wall ☐

Braced Frame ☐

Moment Resisting Frame ☐

Are resisting systems symmetrically located? ☐ Yes ☐ No

4. Floor System

Frame

Concrete Beams ☐

Steel Beams ☐

Steel Bar Joist ☐

Wood Beams ☐

No Framing Members ☐

Precast Concrete Beams ☐

Deck

Concrete Flat Plate ☐

Concrete Flat Slab ☐

Concrete Waffle Slab ☐

Steel Deck ☐

Wood Joists ☐

Wood Plank ☐

Straight Sheathing ☐

Plywood Sheathing ☐

Diagonal Sheathing ☐

Precast Concrete Deck ☐

Concrete Joists ☐

Concrete Plank ☐

Note if concrete topping slab is used over metal decks or concrete plank.

BC-9

Connection Details

	Framing	Decking To Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Floor to Walls

Type ______________________________

Spacing ______________________________

5. Roof System

Frame

Concrete Beams	☐	Steel Truss	☐
Steel Beams	☐	Wood Truss	☐
Steel Bar Joist	☐	No Framing Members	☐
Wood Beams	☐	Precast Concrete Beams or Tees	☐
Wood Rafters	☐		

Deck

Concrete Flat Slab	☐	Concrete Waffle Slab	☐
Metal Decking	☐	Plywood Sheathing	☐
Concrete Slab	☐	Diagonal Sheathing	☐
Concrete Joists	☐	Straight Sheathing	☐
Precast Decking	☐	Concrete Fill	Yes ☐ No ☐

DC-10

Connection Details

	Framing	Decking to Framing
Bolted	☐	☐
Welded	☐	☐
Metal Clips	☐	☐
Wire Fastener	☐	☐
No Connection	☐	☐
Nailed	☐	☐
Metal Hangers	☐	☐

Anchorage Roof to Walls

Type ______________________________

Spacing ______________________________

D. NONSTRUCTURAL ELEMENTS

1. Partitions

Type

	Typical	Corridor
Partial Height	☐	☐
Full Height Floor-To-Ceiling	☐	☐
Floor To Floor	☐	☐
Movable	☐	☐

Composition

Lath and Plaster ☐

Gypsum Wallboard ☐

Concrete Block ☐

Clay Tile ☐

Metal Partitions ☐

DC-11

2. Ceiling

Typical Room

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☐ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

Typical Corridor

Material

Acoustical Tile ☐ Gypsum Board ☐ Plaster ☐

Method of Attachment

Suspended ☐ Metal Channels ☐ Tee Bar Grid ☐

Attached Directly to Structural Elements ☐

3. Light Fixtures

Typical Room

Recessed ☐ Surface Mounted ☐ Pendant (Suspended) ☐

Typical Corridor

Recessed ☐ Surface Mounted ☐ Pendant (Suspended) ☐

4. Mechanical Equipment

Location of Mechanical Equipment Room

Basement ☐ Other Floor ☐ Which Floor ________

Roof ☐

Is Equipment Anchored to Floor? No ☐ Yes ☐

Location of The Following Units

Liquid Storage Tank ________________________________

Cooling Tower ________________________________

Air Conditioning Unit ________________________________

DC-12

5. Roofing

Description

Flat ☐ Arched ☐ Gabled ☐ If arched or gabled, sketch section.

Pitched ☐ Slope (:12)

Parapet No ☐ Yes ☐ Height (______ ft. ______in.) Thickness (_____in.)

Material ______________ Special Anchorage or Bracing Yes ☐ No ☐

Type

Built-up gravel ☐ Gravel ☐ Asphalt or Wood Shingles ☐

Clay Tile ☐ Other ☐

6. Windows

Type

Fixed ☐ Movable ☐

Frame Material:

Aluminum ☐ Steel ☐ Stainless Steel ☐ Wood ☐

Size: Average Size of Casing (____ ft. x _____ ft.)

Average Size of Glazing (____ ft. ____ in. x ____ ft. ____ in.)

How Casing is Attached to Structure

Bolted ☐ Screwed ☐ Clipped ☐ Welded ☐ Nailed ☐

Glazing Attachment to Casing

Elastomeric Gasket ☐ Glazing Bead ☐ Aluminum or Steel Retainer ☐

Other ☐

7. Gas Connection

Flexible Connection to Building ☐ Rigid Connection to Building ☐

Automatic Shut-off ☐ None ☐ Unknown ☐

INSPECTED BY ______________________________

DATE ______________________________

FIELD SUPERVISOR ______________________________

FORM FMA-1

FACILITY NO. ________________ EXPECTED SITE MODIFIED MERCALLI INTENSITY __________

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

VERTICAL RESISTING ELEMENTS							
Type	General Rating (GR) E	General Rating (GR) W	Symmetry (S)	Quantity (Q)	Symmetry Quantity Rating (SQR) [1]	Present Condition (PC)	Sub-Rating (SR1) [2]
TRANSVERSE LOADING							
LONGITUDINAL LOADING							

FOOTNOTES:

1. Symmetry-Quantity Rating (SQR) = $\frac{S + Q}{2}$.
2. Sub-rating SR-1 = $\frac{SQR + 2PC}{3}$.

	TYPE	GENERAL RATING (GR) Earthquake	GENERAL RATING (GR) Wind
A	Steel Moment Resistant Frames	1	1
B	Steel Frames - Moment Resistance Capability Unknown	2	2
C	Concrete Moment Resistant Frames	1	1
D	Concrete Frames - Moment Resistance Capability Unknown	2	2
E	Masonry Shear Walls - Unreinforced	4	2 or 3
F	Masonry or Concrete Shear Walls - Reinforced	1	1
G	Combination - Unreinforced Shear Walls and Moment Resistant Frames	2	2
H	Combination - Reinforced Shear Walls and Moment Resistant Frames	1	1
J	Braced Frames	1	1
K	Wood Frame Buildings, Walls Sheathed or Plastered	1 or 2	2 or 3
L	Wood Frame Buildings, Walls Without Wood Sheathing or Plaster	4	4

SYMMETRY (of Resisting Elements)

1	Symmetrical
2	Fairly Symmetrical
2 or 3	Symmetry Poor
3 or 4	Very Unsymmetrical

NOTE: Add 1 (not to exceed 4) to each rating if a high degree of vertical non-uniformity in stiffness occurs.

QUANTITY (of Resisting Elements)

1	Many Resisting Elements
2	Medium Amount of Resisting Elements
3	Few Resisting Elements
4	Very Few Resisting Elements

NOTE: If exterior shear walls are at least 75% of building length, this rating will be 1.

PRESENT CONDITION (of Resisting Elements)

1	No Cracks, No Damage
2	Few Minor Cracks
3	Many Minor Cracks or Damage
4	Major Cracks or Damage.

NOTE: If masonry walls, note quality of mortar - good or poor. If lime mortar is poor, use next higher rating.

FACILITY NO. ______________

FORM FMA-2

FIELD EVALUATION METHOD

STRUCTURAL SYSTEMS - EARTHQUAKE AND WIND RATING

HORIZONTAL RESISTING ELEMENTS						
Type		Rigidity (R)	Anchorage & Connections (A)	Chords (C)		Sub-Rating (SR2)
				Longitudinal	Transverse	
Roof						
Floors						

Note: Sub-rating SR2 = Largest of R, A or C.

Type
A Diaphragm
B Steel Horizontal Bracing

Rigidity - Ratings
1. Rigid
1.5 Semi-rigid
2.0 Semi-flexible
2.5 Flexible

Anchorage and Connections - Ratings
1 Anchorage confirmed - capacity not computed, but probably adequate.
2 Anchorage confirmed - capacity not computed, but probably inadequate.
3 Anchorage unknown.
4 Anchorage absent.

Chords - Ratings
1 Chords confirmed, but capacity not computed.
2 Chords unknown, but probably present.
3 Chords unknown, but probably not present.
4 Chords absent.

FACILITY NO. ____________________ FORM FMB-1

FIELD EVALUATION METHOD

EXIT CORRIDOR AND STAIR ENCLOSURE WALLS - EARTHQUAKE RATING

TYPE OF WALL	REINFORCEMENT			ANCHORAGE					WALL RATING
	Present	Not Present	Not Known	Mortar Only	Dowels	Screws or Bolts	Other	Not Known	
Brick									
Brick									
Concrete Block									
Concrete Block									
Reinforced Concrete									
Tilt-up or Precast Concrete									
Steel Studs & Plaster									
Wood Studs & Plaster									
Hollow Tile									
Hollow Tile & Plaster									

NOTE: Wall Rating on Basis of A, B, C, and X.

FORM FMB-1

FACILITY NO. ______________ FORM FMB-2

FIELD EVALUATION METHOD

OTHER LIFE HAZARDS - EARTHQUAKE RATING

TYPE OF RISK	RATING
Partitions Other Than on Corridors or Stair Enclosures	
Glass Breakage	
Ceiling	
Light Fixtures	
Exterior Appendages and Wall Cladding*	

Ratings
A = Good
B = Fair
C = Poor
X = Unknown

*A description of some of the ratings for Exterior Appendages and Wall Cladding are:

Description	Rating
Spacing of anchors appears satisfactory	A
Size and embedment of anchors satisfactory	A
Spacing of anchors appears to be too great	B
Size and embedment of anchors appears unsatisfactory	C
Anchorage unknown	X
Anchorage corroded or obviously loose	C
No anchorage	C

EARTHQUAKE GAS CONNECTION		
Present	Not Present	Not Known

FACILITY NO ______________ FORM FME

FIELD EVALUATION METHOD

CAPACITY RATIOS - EARTHQUAKE AND WIND RATING

	General Rating (GR)	Sub-Rating SR1	Sub-Rating SR2	Basic Structural Rating*	Capacity Ratio**
EARTHQUAKE					
WIND					

*Basic Structural Rating = $\frac{\text{GR + 2 (Largest of SR1 or SR2)}}{3}$.

**Capacity Ratio for wind shall be obtained from Form FMC-1. For earthquake, the ratio is obtained from the Basic Structural Rating divided by the Intensity Level Factor at the site as determined from the table below.

Modified Mercalli Scale	Intensity Level Factor
VIII or Greater	1
VII	2
VI	3
V or Less	4

A description of Modified Mercalli Scale is included on table 3.3.

Capacity Ratio Rating	
Capacity Ratio	Rating (In Terms of Risk)
Less than 1.0	Good
1 through 1.4	Fair
1.5 through 2.0	Poor
Over 2.0	Very Poor

FEDERAL EMERGENCY MANAGEMENT AGENCY
NATURAL HAZARD VULNERABILITY SURVEY
DATA INPUT FORM

COUNTY NAME (DO NOT PUNCH)

NEAREST CROSS STREET

IDENT

SECTION A : IDENTIFICATION

STANDARD LOCATION | FACILITY NUMBER | PART | SURVEY OFFICE | UPDATE ACTION | TYPE OF SURVEY | SURVEY DATE (MO. YR.) | STRUCTURAL TYPE | CHANGE EXISTING RECORD ID: STANDARD LOCATION, FACILITY NO. | FOR FEMA USE ONLY: EDIT DATE (MO. YR.), PUNCH DATE (MO. YR.), ORIG. UNIT NO.

BUILDING NAME | BUILDING NO. | DIR | STREET NAME | CITY

STATE | ZIP CODE | USE CODE (A, B, C) | STORIES | PLACE | LATITUDE (DEG MIN SEC) | LONGITUDE (DEG MIN SEC) | FSA NO.

STRUCTURAL

SECTION D: STRUCTURAL

DIMENSIONS: LENGTH, WIDTH, AVERAGE FLOOR AREA, HEIGHT | YEAR DESIGNED | FRAMES | SHEAR WALLS | DIAPH | CONFIGURATION: SIMPLE PLAN, SHEAR WALL FOOTAGE (LONGITUDINAL, TRANSVERSE), OPEN SIDE

CONNECTIONS & DETAILING: STEEL, CONCRETE

EARTHQK

SECTION E: EARTHQUAKE

SEISMIC ZONE | BLDG CODE | SOIL | GEOLOGIC: LAND-SLIDE, LIQUE-FACTION, FAULT-ING, SETTLE-MENT | APPENDAGES: PRECAST PANELS | NONSTRUCTURAL: CONNS, GLASS, ELEV, GAS, GEN FUEL | EQ EMERG. PLAN

WIND

SECTION F: WIND

BASIC WIND SPEED | EXPOS. | DESIGN BASIS | TOP STORY INFORMATION | ROOF | APPENDAGES: GLASS, ROOF OVHANG, PARAPET HEIGHT, APCH PANELS, LARGE DOOR WDTH | WIND EMERG. PLAN

KEY PLAN/REMARKS

TOR

SECTION G: TORNADO

PRIMARY BASEMENT SHELTER: USABLE FLOOR AREA, SHELTER SPACES | SECONDARY BASEMENT SHELTER: USABLE FLOOR AREA, SHELTER SPACES

FLOOD

SECTION H: FLOOD

FLOOD ZONE | STORY OF CULMINATION | LOWEST STORY FLOODED | ESSENTIAL FUNCTION FLOODED | SUPPORT SYSTEM FLOODED | BUILDING ACCESS FLOODED | FLOOD EMERGENCY PLAN

SURVEYED BY: | DATE | CHECKED BY: | DATE

Fig. 1-2. Multi-Hazard DIF.

A. IDENTIFICATION

9. STRUCTURE TYPE (Enter Number)

1. Quonset, steel frame
2. Wood frame
3. Wall bearing
4. Steel frame
5. Reinforced-concrete frame
6. Steel/concrete frame
7. Tunnels
8. Mines

Type floor & roof

1. Wood joist
2. Wood/steel joist, shallow truss
3. Glulam
4. Precast concrete
5. Reinforced concrete slab
6. Flat plate
7. Metal deck/steel frame
8. Metal deck/open-web bar joist
9. Lightweight tension structure

Type walls

1. Masonry, unreinforced
2. Masonry, reinforced
3. Reinforced concrete
4. Precast concrete
5. Infill masonry
6. Corrugated-metal
7. Arch cladding
8. Wood sheathing
9. Stucco
0. Glass

24. BASEMENT
- 0. No basement

Wood
- 1. Wood joists
- 2. Plywood I-joist
- 3. Glulam
- 4. Heavy timber

Concrete
- 5. One-way joists or slab
- 6. Flat plate
- 7. Flat slab
- 8. Two-way slab
- 9. Waffle slab
- 10. Precast

Combination
- 11. Steel joist/concrete slab
- 12. Steel frame/concrete slab
- 13. Wood/steel joists

D. STRUCTURAL

4. FRAMES (Enter Number)

a. Frame class

Wood
- 1. Timber/pole
- 2. Braced frame

Steel
- 3. All metal
- 4. Pinned
- 5. Moment-resistant
- 6. Ductile moment-resistant
- 7. Braced frame

Concrete
- 8. Pinned
- 9. Slab/plate
- 10. Moment-resistant
- 11. Ductile moment-resistant
- 12. Braced frame

Lightweight tension structure
- 13. Tension structure

b. Infill class
- 0. Not infilled
- 1. Infill/partial infill unreinforced or partially reinforced masonry
- 2. Infill/partial infill reinforced masonry

5. SHEAR WALLS (Enter Number)

Wood
- 1. Plywood
- 2. Non-plywood

Steel
- 3. Plate

Masonry
- 4. Ordinary unreinforced
- 5. Monumental unreinforced
- 6. Partially reinforced
- 7. Reinforced

Concrete
- 8. Poured-in-place
- 9. Precast

Mobile/Temporary
- 10. Mobile/Temp Module

6. DIAPHRAGMS (Enter Number)

Wood
- 1. Plywood
- 2. Non-plywood

Steel
- 3. Metal decking or diagonally braced

Concrete
- 4. Reinforced
- 5. Precast
- 6. Unreinforced
- 7. Lightweight tension structure

7. CONFIGURATION
(Yes/No/0 = does not apply)

8. CONNECTIONS AND DETAILING
(Yes/No/0 = does not apply)

9. CONDITION (Enter Number)

1 = good
2 = slight deterioration
3 = major deterioration

E. EARTHQUAKE

2. BUILDING CODE (Enter Number)

1. No seismic design
2. Some seismic design
3. UBC 1949-1970
4. UBC 1973+
5. Above average criteria

3. SOIL
(S = soft, H = hard)

4. GEOLOGIC
0 = no data
1 = low hazard
2 = intermediate
3 = high

5. APPENDAGES
(Yes/No/0 = no data)

6. NONSTRUCTURAL
X = not present
0 = no data
B = braced
U = unbraced

7. EARTHQUAKE PLAN
(Yes/No/0 = no data)

F. WIND

2. EXPOSURE
(A or B)
- A. Protected
- B. Open

3. DESIGN BASIS
(Enter Number)
1. No wind design
2. Some wind design
3. Code, 1961-1975
4. Code, 1976+

7. MASONRY TYPE
(Enter Letter)
- a. Clay brick
- b. Clay tile
- c. Concrete block
- d. Concrete brick
- e. Adobe
- f. Stone

9. INFILL
(Enter Number)

0 = no infill
1 = partial
2 = infill

10. ROOF
(Enter Number)

1. Plywood
2. Non-plywood
3. Metal decking
4. Reinforced concrete
5. Precast
6. Unreinforced concrete
7. Lightweight tension structure

11. ROOF/WALL CONNECTION
(Enter Number)

- 0. No data
- X. No connection
- 1. Plywood
- 2. Non-plywood
- 3. Metal decking
- 4. Reinforced
- 5. Precast concrete
- 6. Unreinforced concrete

13. APPENDAGES
(Enter Letter)

- a. Glass (%)
- b. Overhang (ft)
- c. Parapet height (ft)
- d. Arch panels (Yes/No)
- e. Large door width (ft)

14. WIND EMERGENCY PLAN
(Yes/No/0 = no data)

G. TORNADO SHELTER

1. TORNADO ZONE (Enter Number)

1 = lower risk
2 = higher risk

CONSTRUCTION:
F-RC-HI TYPE
___PRE 1939
___PRE 1973
1920 DATE
___RENOVATED
________DATE

OCCUPANCY:
03/15 USE CODE
___VITAL
___HIGH DENSITY
___VULNERABLE
X 8AM-6PM
___6PM-MDNT
___MDNT-8AM

CONFIGURATION:
4 # STORIES
65 x 200 SIZE
___CMPLX PLAN
___CMPLX ELEV
___SOFT STORY
___OPEN FRONT
H = 45'

CONTENTS:
X HAZARDOUS
___IMPORTANT

DECORATION:
___HEAVY
___OVERHANGING PUBLIC WAY

CONSTRUCTION

EXT. WALLS: FACADE________ SIDES 6" RC

INT. WALLS: BEARING________ PARTITIONS________

DIAPHRAGMS: FLOOR________ ROOF________

FRAME: ___BRACED; ___MOMENT RESISTING; OTHER:________

MISC. FIRE PROOF CONST

CONFIGURATION

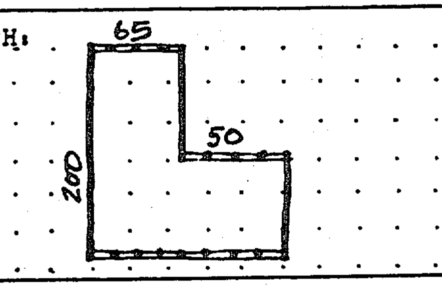
STIFFNESS DISTRIBUTION:

PLAN L- SHAPE

ELEVATION IRREGULAR

MISC.________

PLAN SKETCH:



FUNCTION AND OCCUPANCY

FLOORS:____-____ USES: WAREHOUSE/OFFICE

FLOORS:____-____ USES:________

FLOORS:____-____ USES:________

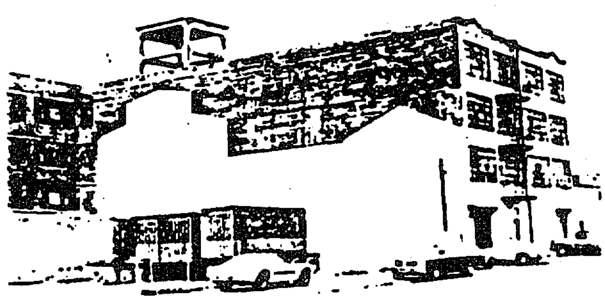


FIGURE A1-2.
Sample Building Information Sheet.

Construction Types Code:

Bearing Wall:

B-UM	Unreinforced Masonry
B-RM	Reinforced Masonry
B-RC	Reinforced Concrete
B-PC	Pre-cast Concrete
B-WD	Wood (stud wall)

Frame:

F-ST-(HI, LI, HC, LC)	Steel
F-RC-( )	Reinforced Concrete
F-WD-( )	Wood (glu-lam, heavy timber)

Exterior skin (heavy infill, light infill, heavy curtain, light curtain)

Frame material

Use Codes:

01	Apartment
02	Hotel
03	Office
04	Retail
05	Restaurant
06	Theatre
07	Auditorium
08	Gymnasium
09	Church
10	School
11	Hospital
12	Parking
13	Car Servicing
14	Manufacturing
15	Warehouse
16	Public facility
17	Public utility

FIGURE A1-3. Key to sample Building Information Sheet.

CRITICAL FACILITIES
FIELD INSPECTION BUILDING DATA SHEET

1. NAME OF BUILDING____________________ CENSUS TRACT__________
2. BLDG. ADDRESS____________________ CITY__________ COUNTY______
3. NO. OF OCCUPANTS____________________ DAY__________ NIGHT__________
4. YEAR BUILT____________________ 5. BLDG. SIZE (SQUARE FEET)__________
6. NO. OF STORIES/FLOOR______________ 7. BASEMENT? YES________ NO________
8. PRIMARY STRUCTURAL SYSTEM

__________ A. STEEL FRAME
__________ B. STEEL FRAME (REINFORCED CONCRETE SHEAR WALL AROUND CENTRAL CORE)
__________ C. WALL BEARING
__________ D. PRECAST COLUMN AND BEAM
__________ E. REINFORCED CONCRETE FRAME
__________ F. REINFORCED CONCRETE FRAME (REINFORCED CONCRETE SHEAR WALL AROUND CENTRAL CORE)
__________ G. FLAT PLATE CONCRETE SLAB
__________ H. WOOD FRAME
__________ I. PLANK AND BEAM FRAME
__________ J. PRE-ENGINEERED METAL BUILDING
__________ K. OTHER STRUCTURAL TYPES DESCRIBE

____

____

9. FOUNDATION TYPE

__________ A. SPREAD
__________ B. STRIP
__________ C. PILES
__________ D. CAISSONS
__________ E. SLAB ON GROUND
__________ F. OTHER

10. WALL TYPE ______________________________
11. FLOOR/ROOF TYPE ______________________________
12. SPECIAL FEATURES ______________________________

____

13. SPECIAL SOIL CONDITIONS ______________________________

____

SINGLE AND MULTI-FAMILY HOUSING DATA SHEET

CENSUS TRACT (DISTRICT) ____________________

ITY ____________ COUNTY ____________

A. SINGLE FAMILY RESIDENCES

1) PREDOMINATE FOUNDATION TYPES
   A. ________ SLAB ON GROUND
   B. ________ POURED CONCRETE OR MASONRY BLOCK FOUNDATION WALL
   C. ________ STONE FOUNDATION WALLS
   D. ________ OTHER

2) PREDOMINATE EXTERIOR WALL, VENEER OR FINISH
   A. ________ BRICK/MASONRY
   B. ________ STONE
   C. ________ WOOD-SIDING OR SHINGLES
   D. ________ STUCCO
   E. ________ OTHER

3) CHIMNEYS, PARAPETS, ORNAMENTATION OR OTHER FALLING HAZARDS ________

4) AGE ________ 5) HEIGHT ________

5) NO. OF OCCUPANTS DAY ________ NIGHT ________

B. MULTI-FAMILY RESIDENCES

1) PREDOMINANT STRUCTURAL TYPE
   A. ________ STEEL FRAME
   B. ________ WALL BEARING
   C. ________ CONCRETE FRAME
   D. ________ FLAT PLATE
   E. ________ WOOD FRAME
   F. ________ PLANK AND BEAM

2) NO. OF OCCUPANTS DAY ________ NIGHT ________

3) AGE ________ 4) HEIGHT ________

5) STORIES/FLOORS ________

CENSUS TRACT ________

NO. OF BLDGS.	COMMERCIAL	PUBLIC NON-EDUCATIONAL	UTILITIES	INDUSTRIAL	EDUCATIONAL
STEEL FRAME					
WALL-BEARING					
CONCRETE FRAME					
FLAT PLATE					
WOOD FRAME					
PLANK AND BEAM					
PRE-ENGINEERED METAL					
1 STORY/FLOOR					
2-5 STORIES/FLOORS					
6-10 STORIES/FLOORS					
OVER 10 STORIES/FLOORS					
AGE PRIOR 1900					
1900-1929					
1930-1949					
1950-1969					
1970-PRESENT					

BUILDING ADDRESS:	BUILDING LOCATION(APN):
NAME OF BUSINESS TENANTS:	OWNERS NAME & ADDRESS:
TYPE OF USE:	NO. OF STORIES: ______ BASEMENT: __________
TYPE OF STRUCTURAL SYSTEM:	
BUILDING SIZE: Square Footage per floor:__________ Total:____________	OCCUPANT LOAD: (UBC-Table 33-A) _____
DATE OF ORIGINAL CONSTRUCTION:__________ DATE OF SUBSEQUENT REMOD./REPAIR AFFECTING THE STRUCTURAL SYSTEM:________	
NAME OF ORIGINAL DESIGNER:________________ NAME OF ORIGINAL CONTRACTOR:________________ COMPANY RESPONSIBLE FOR SUBSEQUENT STRUCTURAL MODIFICATION:__________	
HISTORIC BUILDING CATEGORY: ☐ YES ☐ NO	
REMARKS:	

BUILDING ADDRESS: 550 Example * 552	**BUILDING LOCATION (APN):** 120-15-084
NAME OF BUSINESS TENANTS: 550 * 552 *	**OWNERS NAME & ADDRESS:** *
TYPE OF USE: 550 Coffee House 327f 552 Retail Store 327a	**NO. OF STORIES:** 1 **BASEMENT:** No
TYPE OF STRUCTURAL SYSTEM: C.B. & R.C. Beams & Cols. Flat Roof	
BUILDING SIZE: Square Footage per floor: 5475 2250 MEZ. Total: 7725	**OCCUPANT LOAD:** (UBC-Table 33-A) ≈ 100 $\frac{1/2(5475)}{15} + \frac{1/2(5475)}{30} + \frac{2250}{100}$
DATE OF ORIGINAL CONSTRUCTION: 1951 **DATE OF SUBSEQUENT REMOD./REPAIR AFFECTING THE STRUCTURAL SYSTEM:**	
NAME OF ORIGINAL DESIGNER: N/A **NAME OF ORIGINAL CONTRACTOR:** — **COMPANY RESPONSIBLE FOR SUBSEQUENT STRUCTURAL MODIFICATION:** —	
HISTORIC BUILDING CATEGORY: ☐ YES ☒ NO	
REMARKS: *Names omitted in this publication	

BUILDING INSPECTION QUESTIONNAIRE
(Damage Estimation)

INSPECTORS NAME: ______________________ DATE: 5/9/85

IDENTIFICATION OF STRUCTURE: Bldg. #4

LOCATION: ______________________ ZONE: UBC 4

SPECIFIED INTENSITY (MMI): IX

Adjacency Factor:

The structure endangers another structure: yes
The structure is endangered by another structure: yes
The structure may be a support for another sturcture: yes
The structure may be supported by another structure: yes

STRUCTURES USE: Residential ______ Commercial ✓ Industrial ______

Special Facility no
Lifelines no

Importance Factor:

Impact of structures' use in the regions' economy in the event of an earthquake. negligible

---

MISC. DATA:

Year Structure Built 1890-1900 No. of Stories 1
Floor area per story 4950 (Square Feet)(w/penthouse)
No. of Occupants: Day 15 Night 0
Potential no. of victims 15
Is there a basement? no
Is there a SANITARY crawl space? no

BUILDING CONFIGURATION:

REGULAR ______ Elevation Regularity yes
Plan Symmetry yes
IRREGULAR ✓ Offset center of rigidity maybe
Discontinuity yes

SETBACKS yes

GEOMETRY OF BUILDING (Attach sketches showing overall dimensions, layout, window spacings and sizes): Elevation View ______
Plan View 45' x 110'
Exterior Wall View ______
Typical Shear Wall (core of corner) URM

NO. OF SEPARATION JOINTS:
In Elevation none
In Plan of Superstructure none

EVALUATION	Transverse Direction	Longitudinal Direction
-Plan Symmetry	good average poor	good average poor
-Elevation Regularity	good average poor	good average poor
-Redundancy of Bracing Elements	good average poor	good average poor

---

SPECIAL CHARACTERISTICS:

BUILDING CLASSIFICATION SYSTEM 2.1.1.a

STRUCTURAL REDUNDANCIES: Frame Line no
Plan no

QUALITY OF CONSTRUCTION:

		Good	Avg.	Poor
Workmanship:	Visual Observation	✓	-	-
	Review of Documentation	-	-	-
	Analytical Studies	-	-	-
Overload History Weakening Structural Resistance:				
	* Due to Earthquake	-	-	-
	Due to Fire	-	-	-
	Due to Extreme Environmental Conditions	-	-	-

QUALITY OF DESIGN: *masonry cracks @ mortar joints

Is design regular or special? regular
Proper consideration of soil condition? unknown
Is it designed for earthquake loading? no
Structural ductility? none
Does as-built structure conform to design? n/a
Original designed base shear (kips)? n/a
Computed existing base shear (kips)? n/a
Ratio of existing to original? unknown

CONSTRUCTION MATERIALS:

Quality of materials used? average
Comparison with original material specs? n/a
Masonry or non-masonry? URM
Reinforced or non-reinforced?

SUPERSTRUCTURE

Continuous concrete wall? no
Concrete columns with infill? no
Large heavy pre-cast structural elements? no
Others masonry pilaster and infill
Any signs of distress?

FOUNDATION:

Type? spread
Is soil strength adequate? unknown - probably
(Identify loose sands, sensitive clays, or highly cemented sands clay
Possibility of landslide? no
Possibility of settlement? no - has already occurred
Possibility of sliding? no
Possibility of overturning? no
Possibility of liquefaction? no
Possibility of uplift? no

PRIMARY STRUCTURAL SYSTEM OR ELEMENTS:

Vertical load carrying elements? masonry pilasters
Lateral load carrying elements? URM shear walls

INTERIOR ENVELOPE:

	VERTICAL		NON-VERTICAL
Walls	gypsum	Floors	concrete slab on grade
Doors/Windows	wood/old	Ceilings	gypsum
Others	—	Others	—

EXTERIOR ENVELOPE:

	VERTICAL		NON-VERTICAL
Walls	masonry	Roofs	tin built-up
Doors/Windows	wood/old	Slabs	concrete on grade

EVALUATION:

Some columns added to lower truss chord. A second floor (attic) was then placed on the truss chord.

Possibility of buckling of x-bracings? no
Excessive deflections of long span floors and roofs, etc.? no
Presence of cracks? yes - masonry walls
Excessive compressive force (Possibility of crushing)? no
Additional openings and/or penetrations? no
Possibility of weak column strong beam? no
Additional closures (partitions)? no
Shear wall type and thickness? 8" URM
Is suspended ceiling braced? no

SECONDARY NON-STRUCTURAL SYSTEM OR COMPONENTS:

ARCHITECTURAL:

INTERIOR ELEMENTS

Lights hanging fluorescent
Ornamentations much
Finishes no
Partitions gypsum
Stairways timber/old
Shaftway —
Ceilings gypsum
Others —

EXTERIOR ELEMENTS

Parapets yes
Ornamentations no
Marquees —
Overhangs no
Balconies no
Chimneys no
Railings no
Roofing tin w/ built-up over
Siding no
Cladding no
Fire Escape no
Canopies no
Veneers no
Others —

Possibility of collapse of infill materials? yes

SERVICE SYSTEMS:

ELEVATORS: no
Possibility of cage falling? ______
Adequacy of cage guides and motor mountings ______
MECHANICAL forced air gas
ELECTRICAL old
SPRINKLER none
FIRE CONTROL SYSTEM none
FUEL (HVC) natural gas

Are service systems adequate? yes
Are service systems adequately mounted? no
Will they provide service after an earthquake? no
Possibility of failure in fuel system causing fire? slight
Adequacy of fire control system? no
Possibility of explosion? no
Possibility of release of toxic chemicals? no

CONNECTIONS:

Adequacy of connections between primary structural elements to develop shear resistance? poor
Adequacy of connections between secondary non-structural elements to develop shear resistance? poor
Adequacy of connections between primary structural elements and secondary non-structural components to develop shear resistance? poor
Adequacy of foundations connections? unknown

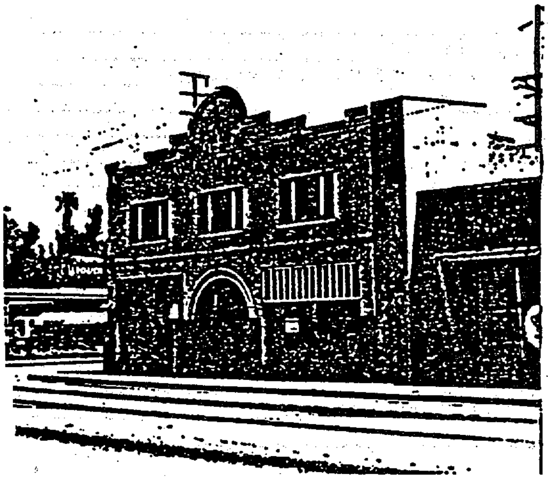
General Remarks:

a. Old URM building with timber roof trusses and sheet metal roof.

b. Reasonably open interior from Floor to roof trusses with a few wood stud/gypsum partitions.

c. Trusses poorly attached to masonry pilasters.

BUILDING DATA FORM



ADDRESS:
AREA: TARGET AREA V
BUILDING NAME:
OWNER:
OCCUPANCY TYPE: B-2 AND R-3
TYPE OF CONSTRUCTION: URM, STUCCO
NUMBER OF STORIES: 2
BUILDING HEIGHT: 24 FEET
CONSTRUCTION: 1912
PLANS AVAILABLE: NONE

SUMMARIZE FINDINGS AND RECOMMENDATIONS HERE:

PRESENTLY VACANT. OWNER IS PRESENTLY IN PROCESS OF GUTTING THE BUILDING IN ORDER TO DO SEISMIC RETROFIT AND REMODELING TO OFFICE/COMMERCIAL USESES. INTERIOR WALLS ON SECOND FLOOR REMOVED SHOWIG STRUCTURAL LUMBER AND INTERIOR SIDE OF WALLS. OLD WOOD IN GOOD SHAPE. SECOND STORY FLOOR IS DIAGONALLY SHEATHED. NO MAJOR CRACKS OR OTHER STRUCTURAL WEAKNESSES NOTED.

SAMPLE

FIELD DATA

ROOF: FLAT

COVERING HOT-MOPPED TAR

PARAPETS: FRONT - MATERIAL: BRICK QUALITY GOOD MORTAR QUAL. GOOD
THICKNESS 8" HEIGHT 2'-3', 7' AT FRONT BRACED OR BOND BEAM: —
OTHER REINF: NONE

ARCHITECTURAL IMPORTANCE: POTENTIAL - UNIQUE STYLE

SIDE AND REAR WALLS: URM, STUCCO COVERED

CORNICES: MATERIAL: NONE
PROJECTION: —
OTHER OBSERVATIONS: ROOF TILE —
COPING —
TOWERS/CHIMNEYS —
SIGNS 3'x 7' PROJECTED OVER SIDEWALK
TANKS —

ATTIC: HEIGHT: — MATERIAL: —
ANCHORS/BOND BEAMS: —

INTERIOR:
FLOORS: WOOD
INTERIOR WALLS: LATH & PLASTER
FRAMING: 2" x 6"

EXTERIOR:
ABUTTING BUILDINGS: SOUTH SIDE ONLY; TIRE STORE

STREET FRONT CONSTRUCTION: 4 LANE BOULEVARD

ARCHITECTURAL SIGNIFICANCE: POTENTIAL

LINTELS: ARCHED FRONT

THIN FACING OVER FRAMING:

SIGNS OR OTHER HAZARDS: ONE SIGN CANTILEVERED OVER FRONT SIDEWALK

OTHER OBSERVATIONS: EXPOSED BRICK ALONG BACK SIDE

SAMPLE

SUMMARY OF CONSTRUCTION

Exterior Walls:

N STUCCO OVER BRICK E EXPOSED BRICK S ABUTS OTHER BUILDING W 2 LARGE WINDOWS

Notes:

Roof: FLAT

Floor(s): WOOD AND CONCRETE

Interior Walls BEING REMODELED FROM LATH AND PLASTER

Frame

Lintels ARCHED

Other: MEZZANENE, 2 STORE FRONT WINDOWS

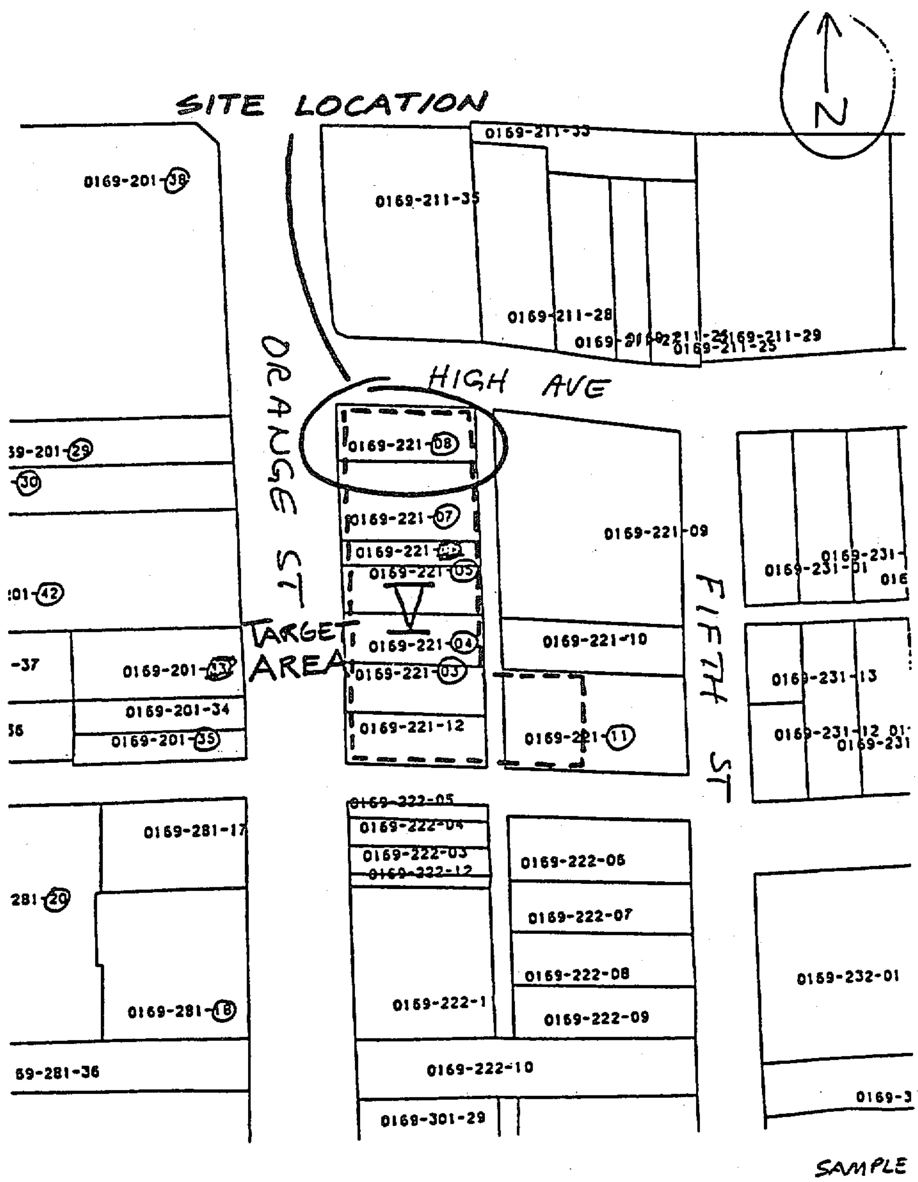
POSSIBLE HAZARDS

X Parapets
Walls
Gables
X Signs
Roof Tile
Coping
Facing
Towers
Marquees
Cornices
Ornamentation
Chimneys Tanks

OTHER NOTES OR REMARKS:

SAMPLE

SKETCHES AND NOTES



CRITICAL FACILITIES
BUILDING STRUCTURE CLASSIFICATION FORM

Name of building ____
Address ____
____
Census tract _________

Primary function of building _____________________________

Year built _____ Year remodeled or rehabilited _____

Plan sketch and dimensions:

Building length (parallel to street) L = ________ feet
Building depth (perpendicular to street) D = ________ feet
Building height (ground level to roof) H = ________ feet
Building size (L*D) A = ________ sq ft
Aspect ratio MAX(H/L,H/D) R = ________

Number of floors (ground floor and above) N = ________
Number of basements B = ________

1984 Replacement value $ ____________

Amount of earthquake insurance $ ____________

Underwriter's building classification _________
[ ] ISO
[ ] Other System: _____________

SURVEY BUILDING CLASSIFICATION: _____________

STRUCTURAL SYSTEM

GENERAL TYPE:

[ ] (1) Mobile Home
[ ] (1) Wood frame

[ ] (2) All metal

[ ] (3) Steel frame
- [ ] Simple
- [ ] Moment resisting
  - [ ] One-way frame
  - [ ] Two-way frame
- [ ] Ductile moment resisting
  - [ ] One-way frame
  - [ ] Two-way frame
- [ ] Poured-in-place concrete fire-proofing
- [ ] Shear walls

[ ] (4) Concrete frame
- [ ] Precast elements
- [ ] Moment resisting
  - [ ] One-way frame
  - [ ] Two-way frame
- [ ] Ductile moment resisting
  - [ ] One-way frame
  - [ ] Two-way frame
- [ ] Shear walls

[ ] (5) Mixed construction
- [ ] Unreinforced masonry
- [ ] Reinforced masonry
- [ ] Tilt-up

[ ] (6) Special earthquake resistant
(Requires written justification)

EMERGENCY SYSTEMS:

[ ] Fire alarms

[ ] Heat and/or smoke detectors

[ ] Fire doors
- [ ] Self closing
- [ ] Automatic closing (Fusable link)

EXTERIOR WALLS:

Location: ____________ story

Type: [ ] Bearing
[ ] Non-bearing
  [ ] Curtain
  [ ] Panel
  [ ] In-filled

Material: [ ] Adobe
[ ] Wood
  [ ] Cripple studs
    [ ] Unbraced
    [ ] Braced
  [ ] Brick veneer
  [ ] Stucco
  [ ] Other   Type: ____________________
[ ] Masonry
  [ ] Hollow
  [ ] Solid
  [ ] Unreinforced
  [ ] Reinforced
  [ ] Brick
  [ ] Tile
  [ ] CMU
[ ] Concrete
[ ] Glass
[ ] Steel panels
[ ] Precast concrete panels
[ ] Other   Type: ____________________

Percent of exterior wall openings: North ___________
East ___________
South ___________
West ___________

Thickness: ______ in

Through-wall ties: ____

INTERIOR WALLS:

Location: ____________ story

Shear Walls:

Type: [ ] None
[ ] Isolated
[ ] Core

Material: [ ] Masonry
  [ ] Hollow

[ ] Solid
[ ] Unreinforced
[ ] Reinforced
[ ] Brick
[ ] Tile
[ ] CMU
[ ] Concrete
[ ] Other Type: ________________

Thickness: ______ in

Partitions:

Type: [ ] Non-moveable
[ ] Moveable

Material: [ ] Wood studs
[ ] Plaster
[ ] Gypsum board
[ ] Plywood panel
[ ] Other Type: ________________
[ ] Metal studs
[ ] Plaster
[ ] Gypsum board
[ ] Plywood panel
[ ] Other Type: ________________
[ ] Plaster
[ ] Masonry
[ ] Brick
[ ] Tile
[ ] CMU
[ ] Non-reinforced
[ ] Reinforced

Top: [ ] Below ceiling
[ ] At ceiling
[ ] At underside of upper floor/roof
Anchorage: [ ] None
[ ] Poor
[ ] Good
[ ] Excellent

Thickness: ______ in

```
FLOOR FRAMING:

     Location: ____________ story

          Type: [ ] Concrete slab on grade
                [ ] Joists
                    [ ] Wood
                    [ ] Steel
                    [ ] Concrete
                    [ ] Not anchored
                    [ ] Anchored
                [ ] Beam/girder
                    [ ] Timber
                    [ ] Steel
                    [ ] Concrete
                [ ] Wood trussed joists
                [ ] Concrete slab
                    [ ] Poured-in-place
                    [ ] Precast
                    [ ] Reinforced
                    [ ] Prestressed
                    [ ] Solid
                    [ ] Hollow
                    [ ] Ribbed
                    [ ] Waffel
                    [ ] Flat slab
                    [ ] Slab w/drops
                    [ ] Slab w/capitals
                    [ ] Slab w/drops and capitals
                    [ ] Precast elements   Type: ______________

          Deck: [ ] Wood
                [ ] Steel
                [ ] Concrete planks
                [ ] Light concrete deck slab (LEQ 3")
                [ ] Heavy concrete deck slab (GTR 3")
                [ ] Other     Type: _______________________

     Diaphragm: [ ] No
                [ ] Poor
                [ ] Good
                [ ] Excellent

     Diaphragm shear transfer connection: [ ] None
                                          [ ] Poor
                                          [ ] Good
                                          [ ] Excellent
```

ROOF FRAMING:

Surface: [ ] Flat
[ ] Sloped
[ ] Curved

Type: [ ] Joists
- [ ] Wood
- [ ] Steel
- [ ] Concrete
- [ ] Not anchored
- [ ] Anchored

[ ] Beam/girder
- [ ] Timber
- [ ] Steel
- [ ] Concrete

[ ] Wood trussed rafters
[ ] Truss/purlin
- [ ] Timber
- [ ] Steel

[ ] Concrete slab
- [ ] Poured-in-place
- [ ] Precast
- [ ] Reinforced
- [ ] Prestressed
- [ ] Solid
- [ ] Hollow
- [ ] Ribbed
- [ ] Waffel
- [ ] Flat slab
- [ ] Slab w/drops
- [ ] Slab w/capitals
- [ ] Slab w/drops and capitals
- [ ] Precast elements Type: ____________

Deck: [ ] Wood
[ ] Steel
[ ] Concrete planks
[ ] Light concrete deck slab (LEQ 3")
[ ] Heavy concrete deck slab (GTR 3")
[ ] Other Type: ____________________

Diaphragm: [ ] No
[ ] Poor
[ ] Good
[ ] Excellent

Diaphragm shear transfer connection: [ ] None
[ ] Poor
[ ] Good
[ ] Excellent

ORNAMENTATION:

Exterior: Inadequately anchored ornamentation and/or veneer above the first story ____________
____
____

Stone coping on parapets, stone or pre-cast ledges, or sculptered sills and key-stones ________________________________
____
____

Interior: [ ] Suspended ceilings
- [ ] Tie wires
  - [ ] Not looped
  - [ ] Looped
- [ ] Lateral bracing
  - [ ] None
  - [ ] Wires
  - [ ] Metal channels

[ ] Suspended light fixtures
- [ ] Wire
- [ ] Chain
- [ ] Pendant (pipe / conduit)

[ ] Poorly anchored chandeliers and/or other ceiling appurtanacies

[ ] Drop-in fluorescent light fixtures

[ ] Bracket-mounted television sets _____
____

[ ] Floor coverings ____________________
____
____

MECHANICAL/ELECTRICAL:

Heating Equipment: _______________
Air Conditioning Equipment: _______________
Electrical Generation and Distribution Equipment: _______________
Elevators: _______________
Escalators: _______________
Miscellaneous Equipment: _______________

Anchorage: (All equipment) _________________________

UNUSUAL CONDITIONS:

Previous EQ damage: ____________________

Settlement: (Differential settlement, cracking, bowing, leaning of walls) ____________________
____
____

Shear walls: (Symmetric or non-symmetric) ____________

Lateral bracing: (Type) ____________________
(Symmetric or non-symmetric) ____________

Building shape: [ ] Rectangular
[ ] Triangular/L-shape/T-shape/H-shape
[ ] "Open front" (U-shape)

Columns: (Continuous, non-continuous) ____________
____

Foundation: [ ] Above grade concrete piers or pedestals
  [ ] Unreinforced
  [ ] Reinforced
[ ] Above grade masonry piers or pedestals
  [ ] Unreinforced
  [ ] Reinforced
[ ] Tiedowns
[ ] Cross-bracing

Floors: (Cracking or sagging) ____________________

Swimming Pools: (On roofs) ____________________

Aspect ratio: R = ______

Other: ____________________
____
____
____

HAZARDOUS EXPOSURES:

Roof tanks: Number: ____________________
Purpose: ____________________
Size: ____________________
Bracing/anchorage: ____________________

Roof signs: ____________________

Parapet walls: [ ] None
[ ] Unreinforced masonry
[ ] Reinforced masonry
[ ] Other Type: ____________________

[ ] Unbraced
[ ] Braced

Overhanging walls: ______________________________

Chimneys: Height above roof: ____________________
Material: ____________________
Anchorage/bracing: ____________________

Pounding: ______________________________

FOUNDATION:

Type: [ ] Strip footings
[ ] Isolated footings
[ ] Mat foundation
[ ] Piles
  [ ] Wood
  [ ] Steel
  [ ] Concrete
[ ] Caissons
[ ] Other Type: ____________________

SOIL TYPE/CONDITION: [ ] Rock or firm alluvium or well-engineered man-made fill
[ ] Soft alluvium
[ ] Poor (natural or man-made)
Remarks: ______________________________
____

CRITICAL FACILITIES
BUILDING STRUCTURE EARTHQUAKE VULNERABILITY RATING FORM

BUILDING: ______________________________ CLASS PML = ______

MODIFICATION FACTOR = [1.0 + (SUM OF MODIFIERS)/100] . . . ______

BUILDING PML = (CLASS PML)*(MODIFICATION FACTOR) . . . . . ______

MODIFIERS:

1. Occupancy type . . . . ______

    (1) Office, Habitational, Hospital, Laboratory, School
        [ ] (-5) Low damageability
        [ ] (0) Average damageability
        [ ] (+5) High damageability

    (2) Mercantile, Restaurant, Church
        [ ] (-10)
        [ ] (-5)
        [ ] (0)

    (3) Manufacturing, Warehousing, Parking structure, Stadium
        [ ] (-15)
        [ ] (-10)
        [ ] (0)

2. Walls. . . . . ______

    A. Exterior walls

    (1) Concrete, poured or precast
    (2) Masonry, reinforced solid or hollow
    (3) Metal
    (4) Glass
    (5) Stucco on studs
        [ ] (-5)
        [ ] (0)
        [ ] (+5)
    (6) Masonry, unreinforced solid
        [ ] (0)
        [ ] (+5)
        [ ] (+10)
    (7) Masonry, unreinforced hollow
        [ ] (0)
        [ ] (+10)
        [ ] (+20)

B. Interior walls and partitions

(1) Concrete, poured or precast
(2) Masonry, reinforced solid or hollow
(3) Plaster or gypsumboard on metal or wood studs
[ ] (-5)
[ ] (0)
[ ] (+5)
(4) Masonry, unreinforced solid or hollow
(5) Tile, hollow clay
[ ] (0)
[ ] (+5)
[ ] (+10)

3. Diaphragms . . . . ______

A. Floors

(1) Concrete, poured
(2) Metal deck with concrete fill
(3) Metal
[ ] (-5)
[ ] (0)
[ ] (+5)
(4) Concrete, precast
(5) Wood: maximum ratio LEQ 2:1 w/ length LEQ 150'
[ ] (0)
[ ] (+5)
[ ] (+10)
(6) Wood: maximum ratio GTR 2:1
[ ] (0)
[ ] (+10)
[ ] (+20)

B. Roof (Null modifier when building GTR 5 stories)

(1) Concrete, poured
(2) Metal deck with concrete fill
(3) Metal
[ ] (-5)
[ ] (0)
[ ] (+5)
(4) Concrete, precast
(5) Wood or gypsum: maximum ratio LEQ 2:1 w/ length LEQ 150'
[ ] (0)
[ ] (+5)
[ ] (+10)
(6) Wood or gypsum: maximum ratio GTR 2:1
[ ] (0)
[ ] (+10)
[ ] (+20)

C. Purlin anchors lacking (+10)

```
4. Ornamentation. . . . . . . . . . . . . . . . . ______

   A. Exterior
        [ ] (     -5)
        [ ] (      0)
        [ ] ( +5,+10)

   B. Interior (includes ceilings and floor covers)
        [ ] (     -5)
        [ ] (      0)
        [ ] ( +5,+10)

5. Mechanical and Electrical Systems. . . . . . . ______

        [ ] (-10, -5)
        [ ] (      0)
        [ ] ( +5,+10)

6. Unusual Conditions . . . . . . . . . . . . . . ______

        Include previous earthquake damage and repairs

        [ ] (-10, -5)
        [ ] (     +5)
        [ ] (+10,+25)

7. Hazardous exposures  . . . . . . . . . . . . . ______

     "Average" means "No exposure"

   A. Roof tanks
        [ ] Null
        [ ] (      0)
        [ ] (    +25)

   B. Roof signs and overhanging walls
        [ ] Null
        [ ] (      0)
        [ ] ( +5,+10)

   C. Founding of adjacent buildings
        [ ] Null
        [ ] (      0)
        [ ] (     +5)

8. Site dependent hazards . . . . . . . . . . . . ______

   A. Foundation materials
        [ ] (  0)  Rock or firm alluvium or
                   well-engineered man-made
                   fill
        [ ] (+10)  Soft alluvium
        [ ] (+25)  Poor (natural or man-made)

                               SUM OF MODIFIERS: ______
```

PRELIMINARY SCREENING
(PRE INSPECTION DATA)

BUILDING NO. 55 INSPECTED BY SAF DATE 1/15/86

DESCRIPTIVE TITLE (Current Use) HOSPITAL BUILDING

CLASSIFICATION ESSENTIAL

AVAILABILITY OF DESIGN DATA DRAWINGS AND CALCULATIONS ARE AVAILABLE

BUILDING DATA:

Number of Stories 3

Height 35' Plan (Show Dimensions) 48' x 192'

CONSTRUCTION:

Structural System Structural Steel Frame

Roof METAL DECK WITH LIGHTWEIGHT FILL

Intermediate Floors METAL DECK WITH CONC. FILL

Ground Floors SLAB ON GRADE

Foundations

Interior Walls

Exterior Walls

LATERAL FORCE RESISTING SYSTEM DMRSF TRANSV. BRACED FRAME LONGIT.

EVALUATION:

General Condition

Earthquake Damage Potential

DAMAGE OBSERVED:

COMMENTS:

APPENDIX B

DETERMINATION OF BASIC STRUCTURAL HAZARD SCORES AND MODIFIERS

This Appendix presents the derivation of the Basic Structural Hazard score and discusses modifications to account for building specific problems and to extend this score to areas outside of California. Sample calculations of probabilities of damage and resulting Basic Structural Hazard scores are included for several building types. A summary of Basic Structural Hazard scores for all structural types and for all regions is found in Table B1.

B.1 Determination of Structural Score S

The Basic Structural Hazard (BSH) is defined for a type or class of building as the negative of the logarithm (base 10) of the probability of damage (D) exceeding 60 percent of building value for a specified NEHRP Effective Peak Acceleration (EPA) loading (reflecting seismic hazard) as:

$$BSH = -\log_{10} [\Pr(D \geq 60\%)] \qquad \text{(B1a)}$$

The BSH is a generic score for a type or class of building, and is modified for a specific building by Performance Modification Factors (PMFs) specific to that building, to arrive at a Structural Score, S. That is,

$$BSH \pm PMF = S \qquad \text{(B1b)}$$

where the

$$\text{Structural Score } S = \log_{10} [\Pr (D \geq 60\%)] \qquad \text{(B1c)}$$

is the measure of the probability or likelihood of damage being greater than 60 percent of building value for the *specific* building.

Sixty percent damage was selected as the generally accepted threshold of major damage, the point at about which many structures are demolished rather than repaired (i.e., structures damaged to 60 percent of their value are often a "total loss"), and the approximate lower bound at which there begins to be a significant potential for building collapse (and hence a significant life safety threat). Value is used as defined in ATC-13 (ATC, 1985), which may be taken to mean replacement value for the building.

The determination of the probability of damage exceeding 60 percent for a class of buildings or structures for a given ground motion defined in terms of Modified Mercalli Intensity (MMI), Peak Ground Acceleration (PGA) or Effective Peak Ground Acceleration is a difficult task for which insufficient data or methods presently exist. In order to fill this gap, earthquake engineering expert opinion was elicited in a structured manner in the ATC-13 project, as to the likelihood of various levels of damage given a specified level of ground motion (ATC, 1985).

The Basic Structural Hazard scores herein were developed from earthquake damage related information, using damage factors (DF) from ATC-13 (ATC, 1985), wherein damage factor is defined as the ratio of dollar loss to replacement value. It is assumed in ATC-13 that, depending on the building class, both modern code and older non-code buildings may be included, and that the damage data are applicable to buildings throughout the state of California. Inasmuch as ATC-13 was intended for large scale economic studies and not for studies of individual structures, damage factors apply to "average" buildings in each class. ATC-13 damage factors were chosen as the

Table B1: Basic Structural Hazard Scores for all Building Classes and NEHRP Areas

	Building Identifier	low (1,2)	Seismic Area (NEHRP MAP AREAS) moderate (3,4)	high (5,6,7)
W	WOOD FRAME	8.5	6.0	4.5
S1	STEEL MRF	3.5	4.0	4.5
S2	BRACED STEEL FRAME	2.5	3.0	3.0
S3	LIGHT METAL	6.5	6.0	5.5
S4	STEEL FRAME W/CONCRETE SW	4.5	4.0	3.5
C1	RC MRF	4.0	3.0	2.0
C2	RCSW NO MRF	4.0	3.5	3.0
C3/S5	URM INFILL	3.0	2.0	1.5
PC1	TILT-UP	3.5	3.5	2.0
PC2	PC FRAME	2.5	2.0	1.5
RM	REINFORCED MASONRY	4.0	3.5	3.0
URM	UNREINFORCED MASONRY	2.5	2.0	1.0

basis for the handbook scores because, at the present time, this is the most complete and systematically compiled source of earthquake damage related information available. Appendix G of ATC-13 contains summaries of experts' opinions of DFs for 78 facility classes (designed in California) due to 6 different levels of input motion. Each ATC-13 expert was asked to provide a low, best and high estimate of the damage factor at Modified Mercalli Intensities VI through XII. The low and high estimates were defined to be the 90% probability bounds of the damage factor distribution. The best estimate was defined for the experts as the DF most likely to be observed for a given MMI and facility class (Appendix E and equation 7.10, ATC-13). This relationship is illustrated in Figure B1.

To incorporate the inherent variability in structural response due to earthquake input and variations in building design and construction, the DF is treated as a random variable—that is, it is recognized that there is uncertainty in the DF, for a given ground motion. This uncertainty is due to a number of factors including variation of structural properties within the category of structure under consideration and variation in ground motion. In ATC-13, DF uncertainty about the mean was examined and found to be acceptably modeled by a Beta distribution although differences between the Beta, lognormal and normal probabilities were very small (see for example ATC-13, Fig. 7.9). For convenience herein, the lognormal rather than Beta distribution was chosen to represent the DF. The lognormal distribution offers the advantage of easier calculation using well-known polynomial approximations. Ideally a truncated lognormal distribution should be used to account for the fact that the DF can be no larger than 100. In the worst case this would have only changed the resulting hazard score by 5%. It should be noted that the lognormal distribution was the ATC-21 subcontractor's preference, and the Beta or other probability distributions could be used in developing structural scores.

For specified building classes (as defined in ATC-13) and for load levels ranging from MMI VI to XII, parameters of damage probability distributions were estimated from the "weighted statistics of the damage factor" given in Appendix G of ATC-13. Weights based on experience level and confidence of the experts were factored into the mean values of the low, best and high estimates (ML, MB, MH) found in that Appendix. For the development of hazard scores, the mean low and mean high estimates of the DF were taken as the 90% probability bounds on the damage factor distribution. The mean best estimate was interpreted as the median DF. Major damage was defined as a DF > .60 (greater than 60 percent damage).

For any lognormally distributed random variable, X, a related random variable, Y=ln(X), is normally distributed. The normal distribution is characterized by two parameters, its mean and standard deviation. The mean value of the normal distribution, m, can be equated to the median value of the lognormal distribution, x_m, by

$$m = \ln(x_m) \qquad \text{(B2)}$$

(Ang and Tang, 1975). Thus if it is assumed that the DF is lognormally distributed with the median = MB, the ln(DF) is normally distributed with mean m=ln(MB). The additional information needed to find the standard deviation, s, is provided by knowing that 90% of the probability distribution lies between ML and MH. Thus approximately 95% of the distribution is below the MH damage factor. From tables of the cumulative standard normal distribution, F(x), where x is the standard normal variate defined by $x=(y-m)/s$, it can be seen that $F(x=1.64)=0.95$. Therefore $(y-m)/s = 1.64$, where in this case y=ln(MH). The standard deviation may then be calculated from $s= (\ln(MH)-m)/1.64$. A similar calculation could be performed using the ML and the 5% cutoff. An average of these two values results in the following equation:

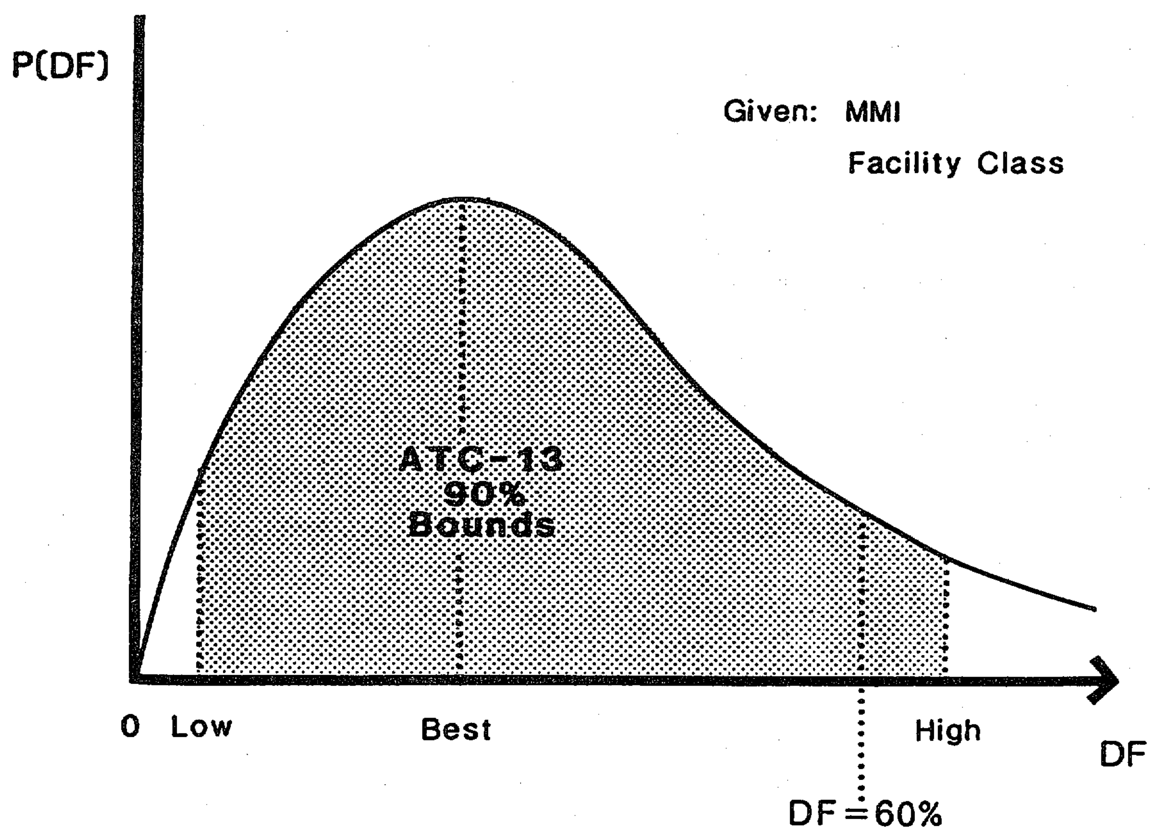

P(DF)
Given: MMI
Facility Class
ATC-13
90%
Bounds
0
Low
Best
High
DF
DF = 60%

Figure B1

$$s = (\ln(MH)-\ln(ML))/3.28 \qquad \text{(B3)}$$

A FORTRAN program was used to calculate the parameters m and s for various ATC-13 facility classes and all MMI levels.

To estimate probabilities of exceeding a 60% DF for various NEHRP areas, MMI was converted to EPA according to:

$$PGA = 10^{(MMI-1)/3} \qquad \text{(B4)}$$

where PGA is in gals (cm/sec^2), and

$$EPA = .75\ PGA \qquad \text{(B5)}$$

Equation B4 is a modification of the standard conversion given in Richter (1958) to arrive at PGA at the mid-point of the MMI value (rather than at the threshold, as given by Richter). Equation B5 is an approximate conversion (N. C. Donovan, personal communication). Only MMI VI to IX were considered, as this is the equivalent range of EPA under consideration in NEHRP Areas 1 to 7.

It was found that large uncertainty in DF for MMI VI and sometimes VII could lead to inconsistencies in the calculated probabilities of damage. To smooth these inconsistencies, $\log_{10}(s)$ was regressed against $\log_{10}(EPA)$. The standard deviations of the damage probability distributions for various EPA levels were calculated from the resulting regression.

Once the parameters of the normal distribution were found, the probability of the DF being greater than 60%, Q, was calculated from the following polynomial approximation of the normal distribution (NBS 55, 1964). For the derivation of structural hazard scores, the standard variate $x = (\ln(60)-m)/s$:

$$Q(x) = Z(x)[b_1t+b_2t^2+b_3t^3+b_4t^4+b_5t^5] \qquad \text{(B6)}$$

where

$$Z(x) = (2\pi)^{-.5}*\exp(-x^2/2) \quad \text{and} \quad t = 1/(1+px)$$

and the constants are

$b_1 = .319381530 \qquad b_2 = -.356563782$

$b_3 = 1.781477937 \qquad b_4 = -1.821255978$

$b_5 = 1.330274429 \qquad p = .2316419$

The resulting values of $\log_{10}(Q)$ (i.e. $\log_{10}[Pr(D >= 60\%)]$) corresponded to initial values of the Basic Structural Hazard score defined in Equation B1. These Structural Hazard scores are presented in Table B2 under NEHRP Map Area 7. These scores for the ATC-13 building classification were then used to determine the scores for the building classifications of ATC-14 (ATC, 1987), which are also employed here in ATC-21 (see left column, Table B1). In many cases, the correspondence of ATC-13 and ATC-14 is one-to-one (e.g., light metal). In some cases, several building types of ATC-13 correspond to one in ATC-14, and were therefore averaged to determine the ATC-21 score. In a few instances, due to inconsistencies still remaining despite the smoothing discussed above, these initial Basic Structural Hazard scores were adjusted on the basis of judgment, by consensus of the Project Engineering Panel. In order to extend the Structural Hazard scores for buildings constructed according to California building practices (which was all that ATC-13 considered) to other NEHRP Map Areas, two factors must be incorporated in the determination of the Structural Hazard score:

1. The seismic environment (i.e., lower EPA values) for NEHRP Map Areas 1 through 6 must be considered.

2. Buildings constructed in places other than the high seismicity portions of California, which probably have not been designed for the same seismic loadings and with the same seismic detailing as in California, must be considered. This latter aspect is termed the "non-California building" factor.

Table B2: Structural Hazard Score Values After Modification for Non-California Buildings (prior to rounding)
(Follows ATC-13 (ATC, 1985) building classifications)

EPA (g)	.05	.05	.10	.15	.20	.30	.40	LOW	MOD	HIGH
NEHRP Area	1	2	3	4	5	6	7	1,2	3,4	5,6,7
WOOD FRAME -LR	8.3	8.3	6.5	5.6	5.3	4.7	4.0	8.5	6.0	4.5
LIGHT METAL	6.6	6.6	6.4	5.8	5.5	5.3	5.7	6.5	6.0	5.5
URM - LR	3.1	3.1	2.0	2.0	1.7	1.4	1.2	3.0	2.0	1.5
URM - MR	2.5	2.5	1.9	1.5	1.3	1.1	1.0	2.5	1.5	1.0
TILT UP	4.8	4.8	4.9	3.1	2.9	1.9	2.4	5.0	3.5	2.0
BR STL FRAME - LR	3.2	3.2	3.7	3.1	3.4	3.0	3.1	3.0	3.5	3.0
BR STL FRAME - MR	2.1	2.1	2.7	2.3	2.8	2.6	2.9	2.0	2.5	3.0
BR STL FRAME - HR	2.3	2.3	2.6	1.9	2.3	1.9	2.0	2.5	2.5	2.0
STL PERIM. MRF - LR	4.3	4.3	5.4	4.7	4.9	5.5	5.4	4.5	5.0	5.5
STL PERIM. MRF - MR	3.7	3.7	4.5	3.7	3.8	4.1	3.9	3.5	4.0	4.0
STL PERIM. MRF - HR	3.6	3.6	3.5	2.7	2.6	2.7	2.4	3.5	3.0	2.5
STL DISTRIB MRF - LR	3.1	3.1	3.8	3.5	3.8	4.4	4.5	3.0	3.5	4.5
STL DISTRIB MRF - MR	3.0	3.0	3.8	3.3	3.5	3.8	3.7	3.0	3.5	4.0
STL DISTRIB MRF - HR	3.0	3.0	3.4	2.8	2.8	2.8	2.5	3.0	3.0	2.5
RCSW NO MRF - LR	5.4	5.4	5.4	3.9	4.6	4.0	3.5	5.5	4.5	4.0
RCSW NO MRF - MR	4.6	4.6	4.1	2.7	3.4	2.9	2.5	4.5	3.5	2.5
RCSW NO MRF - HR	3.5	3.5	3.2	2.1	2.5	2.1	1.8	3.5	2.5	2.0
URM INFILL - LR	2.8	2.8	2.1	1.6	1.3	1.2	1.1	3.0	1.5	1.0
URM INFILL - MR	2.5	2.5	1.7	1.2	1.1	1.1	1.1	2.5	1.5	1.0
URM INFILL - HR	2.3	2.3	1.5	1.1	1.0	1.0	1.1	2.5	1.0	1.0
ND RC MRF - LR	4.2	4.2	4.2	2.4	2.9	2.7	2.2	4.0	3.0	2.5
ND RC MRF - MR	3.9	3.9	3.7	2.3	2.2	2.0	1.7	4.0	2.5	2.0
ND RC MRF - HR	3.4	3.4	3.5	2.1	2.2	2.1	1.8	3.5	2.5	2.0
D RC MRF - LR	7.6	7.6	8.7	6.6	7.0	6.5	5.7	7.5	7.5	6.0
D RC MRF - MR	5.0	5.0	6.3	4.8	5.4	5.4	4.9	5.0	5.5	5.0
D RC MRF - HR	5.7	5.7	5.9	4.0	4.3	3.8	3.2	5.5	4.5	3.5
PC FRAME - LR	3.0	3.0	3.8	2.3	2.0	1.4	1.6	3.0	2.5	1.5
PC FRAME - MR	1.8	1.8	2.2	1.7	2.2	1.8	1.2	2.0	2.0	1.5
PC FRAME - HR	1.6	1.6	2.3	1.4	1.7	1.4	1.0	1.5	2.0	1.0
RM SW W/O MRF - LR	3.9	3.9	5.4	4.5	4.1	3.5	2.9	4.0	4.5	3.0
RM SW W/O MRF - MR	3.4	3.4	4.3	3.4	3.1	2.6	2.2	3.5	3.5	2.5
RM SW W/O MRF - HR	2.7	2.7	3.4	2.6	2.3	1.9	1.7	2.5	3.0	2.0
RM SW W/ MRF - LR	4.0	4.0	5.8	5.0	4.7	4.1	3.6	4.0	5.0	4.0
RM SW W/ MRF - MR	5.7	5.7	7.6	5.8	5.1	3.9	3.1	5.5	6.0	3.5
RM SW W/ MRF - HR	5.9	5.9	8.1	6.2	5.5	4.3	3.4	6.0	6.5	4.0
LONG SPAN	4.2	4.2	3.9	3.2	3.3	3.5	3.2	4.0	3.5	3.5

With regard to the first of these factors, to facilitate calculating the final Structural Hazard scores for the EPA loadings in NEHRP Areas 1 through 6, $\log_{10}[\log_{10}(\text{Structural Hazard Score})]$ was regressed against EPA and scores were calculated from the resulting regression. These values represent the values for a "California building" (i.e., designed and built according to standard California seismic practices) in a different NEHRP Map Area. The extension of the scoring system to structures outside of California (i.e., "non-California buildings") is discussed below.

B.2 Extension to Non-California Building Construction

Due to the nature of data compiled in ATC-13, the above Structural Hazard scores are appropriate for "average" buildings designed and built in California, subjected to seismic loadings appropriate for NEHRP Map Area 7. In regions where building practices differ significantly from California (i.e., NEHRP Map Area 7) building practices, the Structural Hazard score should be modified. It would be expected that in regions where seismic loading does not control the design, this would lead to an increase in the value of the Structural Hazard score.

An example of this "non-California building" effect might be a reinforced masonry (RM) building in NEHRP Map Area 3, where local building codes typically may not have required any design for seismic loading until recently, if at all. This is not to say that buildings in NEHRP Map Area have no lateral load (and hence seismic) capacity. Design for wind loads would provide some lateral load capacity, although lack of special details might result in relatively little ductility. However, interior masonry partitions (e.g., interior walls built of concrete masonry units, CMU) might typically be unreinforced, with ungrouted cells, for example. Although the building structure could thus be fairly classified as RM, failure and probable collapse of most of the interior walls would be a major life-safety hazard, as well as resulting in major property damage. Although the exterior walls are reinforced, they will likely lack details required in UBC Seismic Zones 3 and 4, and thus will likely have less ductility. Therefore, the Structural Hazard score in NEHRP Map Area 3 for this building type should be lower than it would be for a "California" building, if the seismic loading were the same. Given that the seismic loading in NEHRP Map Area 3 is less than in most of California, the actual resulting score may be higher or lower, depending on the seismic capacity/demand ratio.

Some building types, on the other hand, such as older unreinforced masonry (URM) may be no different in California than in most other parts of the United States, so that the seismic capacity is the same in many NEHRP areas. Since the seismic loading is less for most non-California map areas (e.g., NEHRP Map Areas 1, 2, 3), the seismic capacity/demand ratio increases for these type of buildings for NEHRP Map Areas 1, 2, 3. Similarly, building types whose seismic capacity is the same will have higher Basic Structural Hazard scores in the lower seismicity NEHRP Map Areas.

Quantification of the change in Structural Hazard score due to variations in regional seismicity can be treated in a rather straightforward manner, as outlined above. Changes in the Structural Hazard score due to variations in local design or building practices, as discussed above, however, is difficult because seismic experience for these regions is less, and expert opinion data similar to ATC-13 did not exist for non-California buildings. In the course of the development of the *ATC-21 Handbook* therefore, expert opinion was sought in order to extend the ATC-13 information to non-California building construction. Information was sought in a structured manner from experienced engineers in NEHRP Areas 1 to 6, asking them to compare the performance of specific building types in their regions to

California-designed buildings of the same type. After reviewing and comparing the responses, a composite of all responses for a region was sent to the experts, who were then asked, based on these composite results, for their final estimate of the seismic performance for each building type for their region.

Generally, for the same level of loading, the experts expected higher damage for buildings in their regions than for similar structures built in California, as might be expected. For a given NEHRP Map Area, although there was substantial scatter in these experts' responses, in most cases the responses could be interpreted such that the non-California building DF could be considered to differ by a constant multiple from the corresponding "California building" DF. That is, responses from all experts in each region were averaged and used to estimate the modification constant for each building type.

These modification constants (MC), presented in Table B3, were used to change the value of the mean best estimate from ATC-13 (MB) to a best estimate for each NEHRP Map Area (BENA) according to the following equation:

$$BENA = MC*MB \tag{B7}$$

Keeping the standard deviation constant (as calculated in equation B3) and using the best estimate of the DF (BENA) from equation B7, Structural Hazard scores were calculated for each region using the methodology described in Section B.1. These structural scores are presented in Table B2, for each NEHRP Map Area.

Because the derived scores were based on expert opinion, and involved several approximations as discussed above, it was felt that the precision inherent in the Structural Hazard scores only warranted expressing these values to the nearest 0.5 (i.e., all were rounded to the nearest one half: .3 rounded to .5, 1.2 to 1.0 and so on). A comparison of scores for low rise (1 to 3 stories) and medium rise (4 to 7 stories) structures after rounding showed little or no difference for most building classes. Therefore, these values (before rounding) were averaged for low- and medium-rise buildings. This value, appropriate for low- and medium-rise buildings, is designated as the Basic Structural Hazard score. For high-rise construction (8+ stories), this is modified by a high-rise Performance Modification Factor (PMF). This high-rise PMF is a function of building class and was calculated by subtracting the Basic Structural Hazard score for low- and mid-rise buildings from that determined for high-rise buildings.

Lastly, a comparison of scores for different NEHRP Map Areas revealed very little difference of Structural Hazard scores for certain levels of seismicity. The scoring process was therefore simplified by grouping high, moderate, and low seismicity NEHRP areas together as follows:

Seismicity	NEHRP Areas
High	5, 6, 7
Moderate	3, 4
Low	1, 2

B.3 Sample Calculation of Basic Structural Hazard Scores

A sample calculation is presented here for ATC-13 facility class 1 (wood frame), based on data taken from Appendix G in ATC-13 (ATC, 1985), shown in Table B4. Although ATC-13 provided data for MMI VI to XII, the data for MMI greater than X do not correspond to the NEHRP Map effective peak accelerations. Therefore they were not included in developing the scores for this Rapid Screening Procedure (RSP).

Table B3: ATC-21 Round 2 Damage Factor Modification Constants

Structure Type	NEHRP Map Area				
	1,2	3	4	5	6
Wood Frame	1.0	1.3	1.3	1.2	1.0
Steel Moment Resisting Frame (S1)	1.9	1.2	1.4	1.3	1.0
Steel Frame with Steel Bracing or Concrete Shear Walls	1.9	1.2	1.4	1.1	1.1
Light Metal	1.1	1.1	1.3	1.3	1.2
Steel Frame or Concrete Frame with Unreinforced Masonry Infill Walls	1.2	1.2	1.3	1.3	1.2
Concrete Moment Resisting Frame	2.2	1.3	1.5	1.2	1.0
Concrete Shear Wall	1.7	1.3	1.5	1.1	1.0
Tilt-up (PC1)	2.0	1.2	1.5	1.3	1.4
Precast Concrete Frames	2.9	1.1	1.8	1.2	1.3
Reinforced Masonry (RM)	2.9	1.1	1.3	1.1	1.0
Unreinforced Masonry	1.1	1.2	1.0	1.0	1.0

The mean and standard deviation of the Normal distribution are calculated from equations B2 and B3 with the results shown in Table B5.

A regression of $\log_{10}(s)$ versus $\log_{10}(\mathrm{EPA})$ yields the following equation:

$$\log_{10}(s) = -0.409 - 0.192*\log_{10}(\mathrm{EPA})$$

Using values of s obtained from the above equation and the polynomial approximation of the normal distribution given in Equation B6, probabilities of exceeding 60 percent damage were calculated for EPA values of .35 and lower. The resulting probabilities and hazard scores are shown in Table B6.

Finally $\log_{10}[\log_{10}(\mathrm{BSH})]$ was regressed against EPA resulting in the following equation:

$$\log_{10}[\log_{10}(\mathrm{BSH})] = -0.0101 - 0.532*\mathrm{EPA}$$

Values of the Basic Structural Hazard score for California buildings calculated from the above equation for specified EPA are shown below:

EPA(g)	BSH
0.05	8.30
0.10	7.32
0.15	6.50
0.20	5.82
0.30	4.75
0.40	3.97

BSH = 3.97 corresponding to an EPA of 0.4g is the score for NEHRP Map Area 7. To calculate BSH for other NEHRP Map Areas the same process must be used with the modified mean damage factor described in Section B.2. For wood-frame structures the modification constants developed from the questionnaires are:

NEHRP Map Area	1	2	3	4	5	6
Modification Constant	1	1	1.3	1.3	1.2	1

Using these constants, the modified median damage factors for NEHRP Map Area 3, for example, are (see Equation B7):

MMI	VI	VII	VIII	IX
Median DF	1.0	1.9	5.9	11.5

Repeating the same procedure using the natural log of these median DF to calculate the mean of the normal distribution and the same standard deviations shown above, the Structural Hazard score is calculated for each NEHRP Map Area. The final values for the example given here (wood-frame buildings), before and after rounding to the nearest half, are shown in Table B7 for this example of wood buildings and in Table B2 for all building types.

Finally, because there appeared to be little variation between some NEHRP Map Areas, these were grouped together into three areas, with corresponding BSH values (see Table B1). For the example of wood-frame buildings, resulting values are:

	NEHRP Map Areas	BSH
LOW	1, 2	8.5
MODERATE	3, 4	6.0
HIGH	5, 6, 7	4.5

Table B4

MMI	PGA (g)	EPA (g)	Damage Factor (%) Mean Low (ML)	Mean Best (MB)	Mean High (MH)
VI	0.05	0.04	0.2	0.8	2.6
VII	0.10	0.08	0.7	1.5	4.8
VIII	0.22	0.16	1.8	4.7	11.0
IX	0.47	0.35	4.5	9.2	19.7

Table B5

EPA (g)	ln (ML)	ln (MH)	*s* (std. dev.)	*m* (mean=ln{MB})
0.04	-1.609	0.956	0.782	-0.223
0.08	-0.356	1.569	0.587	0.405
0.16	0.588	2.398	0.552	1.548
0.35	1.504	2.981	0.450	2.219

Table B6

EPA	$Pr(D \geq 60)$	BSH
0.04	2.69×10^{-9}	8.57
0.08	3.80×10^{-9}	8.42
0.16	1.91×10^{-6}	5.72
0.35	4.07×10^{-5}	4.39

Table B7

NEHRP	EPA (g)	Final Values	BSH
1	0.05	8.3	8.5
2	0.05	8.3	8.5
3	0.10	6.45	6.50
4	0.15	5.6	5.5
5	0.20	5.26	5.5
6	0.30	4.75	5.0
7	0.40	3.97	4.0

The final resulting values of Basic Structural Hazard score presented in Table B1 are intended for use nationwide. However, local building officials may feel that building practice in their community differs significantly from the conditions typified by the Modification Constants (MCs) in Table B3. The computer source code and data employed for this study is therefore furnished (Figure B2) so that alternative MCs may be employed to generate BSH scores based on an alternative set of MCs. An alternative computation might be conducted, for example, if a community in NEHRP Map Area 5 (e.g., Memphis, TN) felt that the MCs for Map Area 4 were more appropriate. Example resulting BSH scores would then be:

Wood	5.0
Light Metal	5.5
URM	1.5
Tilt-up	2.5

Note that if non-standard BSH scores are thus computed, PMFs should be reevaluated. In most cases, however, the BSH scores in Table B1 should be appropriate.

The interpretation of these values is rather straightforward—a value of 8.5 in Low seismicity areas indicates that on average wood-frame buildings, when subjected to EPA of 0.05g, have a probability of sustaining major damage (i.e., damage greater than 60 percent of their replacement value) of $10^{-8.5}$. In High seismicity areas, where the EPA is 0.3g to 0.4g, the probability of sustaining major damage is $10^{-4.5}$.

Thus, BSH has a straightforward interpretation: if BSH is 1, the probability of major damage is 1 in 10, if BSH is 2, the probability of major damage is 1 in 100, if BSH is 3, the probability of major damage is 1 in 1000, and so on.

It should be noted that BSH as defined and used here is similar to the structural reliability index, Beta (Hasofer and Lind, 1974), which can be thought of as the standard variate of the probability of failure (if the basic variables are normally distributed, which is often a good approximation). For values of BSH between about 0 and 5 (typically the range of interest herein), Beta and BSH are approximately equal. Further, it should be noted that research into the Beta values inherent in present building codes (NBS 577, 1980) indicates that Beta (or BSH) values of 3 for gravity loads and about 1.75 for earthquake loads are typical.

B.4 Performance Modification Factors

There are a number of factors that can modify the seismic performance of a structure causing the performance of an individual building to differ from the average. These factors basically are related to significant deviations from the normal structural practice or conditions, or have to do with the effects of soil amplification on the expected ground motion.

Deviations from the normal structural practice or conditions, in the case of wood frame buildings for example, can include deterioration of the basic wood material, due to pests (e.g., termites) or rot, or basic structural layout, such as unbraced cripple walls or lack of bolting of the wood structure to the foundation. The number and variety of such performance modification factors, for all types of buildings, is very large, and many of these cannot be detected from the street on the basis of a rapid visual inspection. Because of this, based on querying of experts and checklists from ATC-14, a limited number of the most significant factors were identified. Factors considered for this RSP were limited to those having an especially severe impact on seismic performance. Those that could not be readily observed from the street were eliminated. The performance modification factors were assigned values, based on judgment, such that when

```
C THIS PROGRAM FINDS THE STRUCTURAL SCORES FOR THE ATC21 HANDBOOK
C USING DATA FROM ATC13
C A LOGNORMAL DISTRIBUTION FOR DAMAGE IS ASSUMED
C T. Anagnos and C. Scawthorn 1987,1988
C---------------------------------------------------
C
C
      dimension x(10),y(10),epa(7)
      open(5,file='atcs.dat',status='old')
      open(6,file='outputcs',status='old')
      data epa /.05,.05,.1,.15,.2,.3,.4/
      write(6,200) (epa(i),i=1,7)
      write(6,210) (i,i=1,7)
200   format('EPA',17x,7(f5.2),'     LOW  MOD  HIGH       M2
H2')
 210   format('NEHRP Area           ',7(i5))
 202      FORMAT (' ')
          WRITE (6,202)
       read(5,*) ntype
       do 1 i=1,ntype
           call dfread
 1     continue
       end
c---------------------------------------------------
subroutine dfread
dimension pga(7),s(7),p(7),stvar(7),sigma(7),x(7),y(7)
DIMENSION dmodfy(7),dbest(7),sfinal(7), bldg(10)
       real lnlow(7),lnbest(7),lnhigh(7),epa(10)
       read(5,100) (bldg(i),i=1,6)
100    format(6a4)
c READ MODIFICATION FACTORS FOR EACH NEHRP AREA
       read(5,*) (dmodfy(j),j=1,7)
C CONVERT MMI TO PGA
       do 2 i=1,7
         read(5,*) xmmi,dlow,dbest(i),dhigh
         pga(i)=10**(((xmmi+0.5)/3.)-0.5)/981.
         lnlow(i)=alog(dlow)
       lnhigh(i)=alog(dhigh)
 2     continue
       do 50 nehrp=1,7
       do 7 i=1,7
       temp=dbest(i)/dmodfy(nehrp)
       if (temp.gt.100.) temp=100.
         lnbest(i)=alog(temp)
         x(i)=alog10(pga(i))
 7     continue
       do 3 i=1,7
 3     continue
 201   format(' ',4(f10.5,1x))
C COMPUTE STANDARD DEVIATION OF THE LOGNORMAL DISTRIBUTION
       do 4 i=1,7
         sigma(i)=(lnhigh(i)-lnlow(i))/3.28
         y(i)=alog10(sigma(i))
 4     continue
```

Figure B2

```
     FORTRAN PROGRAM NEHRP.FOR
     PAGE 2

C REGRESS LOG(SIGMA) AGAINST LOG(PGA)
      n=7
      call regres(x,y,n,a,b)
 202  format(' a=',f8.3,'b= ',f8.3)
C COMPUTE PROBABILITIES OF EXCEEDANCE USING AN APPROXIMATION
C OF THE LOGNORMAL DISTRIBUTION
C STVAR = STANDARD VARIATE
      c1=.31938153
      c2=-.356563782
      c3=1.781477937
      c4=-1.821255978
      c5=1.330274429
      do 5 i=1,7
      stvar(i)=(alog(60.)-lnbest(i))/10**(a+b*x(i))
      t=1./(1.+stvar(i)*0.2316419)
c Approximation is invalid for large negative standard
c variates
      if(stvar(i).lt.-3.) p(i)=1.0
      if(stvar(i).lt.-3.) goto 8
      ctot=c1*t+c2*t**2+c3*t**3+c4*t**4+c5*t**5
      p(i)=exp(-.5*stvar(i)**2)/sqrt(6.283185308)*ctot
C ACCOUNT FOR ROUND OFF ERROR IN THE APPROXIMATION
 8     continue
      if(p(i).gt.1.0) p(i)=1.0
      if(p(i).lt.0.0) p(i)=0.0
C CALCULATE THE STRUCTURAL SCORE "S"
       s(i)=-1.*alog10(p(i))
 5    continue
C FIND WHERE STRUCTURAL SCORE BECOMES NEGATIVE
        marker=0
      do 6 j=1,4
      temp=alog10(s(j))
       if(temp.le.0.0) marker=j
       if (temp.le.0.0) goto 10
       y(j)=alog10(temp)
 6     continue
       goto 11
 10    continue
 11    continue
       n=4
       if(marker.ne.0) n=marker-1
C REGRESS LOG(S) AGAINST PGA
      call regress(pga,y,n,ascor,bscor)
       call finscr(ascor,bscor,nehrp,score)
       sfinal(nehrp)=score
 510   format(' a=',f10.3,'b= ',f10.3)
 204   format(' x=',f8.5,'p=',f8.5,'s=',f8.5)
 50    continue
       xl=.5*nint((sfinal(1)+sfinal(2))/(2*.5))
       xm=.5*nint((sfinal(3)+sfinal(4)+sfinal(5))/(3*.5))
       xh=.5*nint((sfinal(6)+sfinal(7))/(2*.5))
       xm2=.5*nint((sfinal(3)+sfinal(4))/(2*.5))
       xh2=.5*nint((sfinal(5)+sfinal(6)+sfinal(7))/(3*.5))
 200  format(' ',10a4)
```

Figure B2

```
     FORTRAN PROGRAM NEHRP.FOR
     PAGE 3
210  format(' ',5A4,7(f5.1),3x,3f5.1,3x,2f5.1)
     write(6,210)
     (bldg(i),i=1,5),(sfinal(i),i=1,7),xl,xm,xh,xm2,xh2
     return
     end
c-------------------------------------------------------------
c SUBROUTINE TO CALCULATE THE FINAL SCORE FOR EA NEHRP AREA
c-------------------------------------------------------------
      subroutine finscr(a,b,narea,score)
      dimension epa(7),s(7)
      data epa/.05,.05,.1,.15,.2,.3,.4/
      do 1 i=1,7
       s(i)=10**(10**(a+b*epa(i)*4/3))
   1  continue
      score=s(narea)
 200  format(' nehrp area',7(i5,1x))
 210  format(' score     ',7(f5.2,1x))
      return
       end
c-----------------------------------------------
C SUBROUTINE TO PERFORM LINEAR REGRESSION AND PROVIDE THE
C RESULTING CONSTANTS
C-----------------------------------------------
      subroutine regres(x,y,n,a,b)
      dimension x(10),y(10)
 500 format(' x',10f10.6)
 501 format(' y',10f10.6)
      sumx=0.0
      sumxy=0.0
      sumy=0.0
      sumx2=0.0
      do 1 i=1,n
      sumx=sumx+x(i)
      sumx2=sumx2+x(i)**2
      sumy=sumy+y(i)
      sumxy=sumxy+x(i)*y(i)
 1    continue
      b=(sumxy-sumx*sumy/n)/(sumx2-sumx*sumx/n)
      a=(sumy-b*sumx)/n
      return
      end
```

Figure B2

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WOOD FRAME - LR	BR STL FRAME -MR	STL DISTRIB MRF-MR	URM INFILL - MR	D RC MRF - MR	RM SW W/O MRF - MR
1 1 .8 .8 .87 1 1	.53 .53 .85 .7 .91 .87 1	.5 .5 .85 .7 .8 1 1	.83 .83 .82 .78 .77 .85 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .85 .91 .97 1
6 0.20 0.80 2.60	6 0.01 0.80 2.90	6 0.01 0.80 2.70	6 0.60 3.40 10.30	6 0.40 1.30 3.30	6 0.20 1.20 3.20
7 0.70 1.50 4.80	7 0.40 5.80 6.50	7 0.30 1.70 4.80	7 1.80 8.20 23.20	7 1.30 3.40 6.90	7 1.50 3.50 8.90
8 1.80 4.70 11.00	8 2.20 7.00 13.50	8 1.50 4.30 9.60	8 7.20 20.60 40.30	8 2.30 5.80 12.60	8 2.90 9.90 20.20
9 4.50 9.20 19.70	9 6.20 11.90 22.10	9 3.20 7.10 14.80	9 14.50 33.60 58.80	9 5.40 10.80 20.10	9 6.60 17.90 32.70
10 8.80 19.80 39.70	10 10.50 20.40 32.80	10 5.50 12.60 19.30	10 25.60 47.30 80.40	10 8.60 16.90 26.30	10 15.80 30.50 51.60
11 14.40 24.40 47.30	11 17.00 30.10 49.60	11 8.40 19.60 33.70	11 41.60 68.00 94.80	11 16.80 28.40 40.40	11 26.90 46.10 73.60
12 23.70 37.30 61.30	12 23.00 41.80 62.40	12 11.50 30.30 42.10	12 60.30 80.70 99.20	12 24.10 37.10 51.50	12 38.50 59.70 89.50

LIGHT METAL	BR STL FRAME -HR	STL DISTRIB MRF-HR	URM INFILL - HR	D RC MRF - HR	RM SW W/O MRF - HR
.9 .9 .9 .8 .77 .83 1	.53 .53 .85 .7 .91 .87 1	.5 .5 .85 .7 .8 1 1	.83 .83 .82 .78 .77 .85 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .85 .91 .97 1
6 0.01 0.40 1.60	6 0.01 0.90 4.90	6 0.01 0.50 2.70	6 1.30 4.80 14.70	6 0.50 1.80 3.90	6 0.30 1.20 4.00
7 0.50 1.10 2.70	7 0.70 5.40 10.20	7 0.40 2.40 6.50	7 2.30 11.00 28.00	7 1.50 3.20 7.80	7 1.60 5.10 12.50
8 0.90 2.10 5.70	8 3.90 10.20 21.80	8 1.70 4.90 12.70	8 8.70 23.50 48.40	8 3.10 6.90 17.50	8 3.40 13.30 25.90
9 2.10 5.60 10.50	9 10.00 17.70 26.10	9 3.30 9.60 18.60	9 18.70 43.90 67.40	9 6.10 13.70 24.70	9 11.10 22.50 44.10
10 6.00 12.90 23.50	10 14.40 22.80 40.30	10 6.60 16.30 26.40	10 33.60 56.20 89.80	10 10.90 21.50 33.60	10 19.20 36.80 65.40
11 9.80 22.30 34.40	11 20.60 37.80 61.20	11 8.40 24.20 41.40	11 44.80 68.90 99.99	11 14.80 31.80 47.20	11 31.30 55.00 82.80
12 17.60 31.30 44.00	12 27.60 50.50 77.50	12 11.80 32.30 50.20	12 60.40 76.90 99.99	12 19.50 38.60 56.80	12 44.00 70.50 97.20

URM - LR	STL PERIM. MRF -LR	RCSW NO MRF - LR	MD RC MRF - LR	PC FRAME -LR	RM SW W/ MRF - LR
.9 .9 .82 1 1 1 1	.5 .5 .85 .7 .8 1 1	.6 .6 .8 .65 .91 .97 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .57 .83 .8 1	.35 .35 .9 .85 .91 .97 1
6 0.90 3.10 7.50	6 0.01 0.70 2.20	6 0.10 0.50 1.90	6 0.20 1.30 3.60	6 0.10 1.10 4.20	6 0.10 1.00 2.40
7 3.30 10.10 26.40	7 0.50 1.70 3.90	7 0.80 2.80 6.30	7 1.90 4.20 10.10	7 0.80 2.80 8.40	7 0.80 2.40 7.60
8 8.90 22.50 48.50	8 2.00 3.80 7.90	8 2.60 6.60 12.50	8 5.40 12.10 21.80	8 3.20 8.00 18.90	8 3.10 5.90 12.40
9 22.10 41.60 74.90	9 3.70 7.20 11.50	9 5.60 13.00 22.00	9 12.80 21.10 38.20	9 10.00 23.20 33.90	9 6.50 11.90 20.10
10 41.90 64.60 93.60	10 6.90 13.90 20.90	10 11.50 23.60 34.10	10 17.50 31.80 50.80	10 18.90 37.60 56.90	10 10.70 18.40 33.40
11 57.20 78.30 97.30	11 10.10 22.20 32.20	11 20.20 35.50 51.20	11 27.20 47.50 65.60	11 24.20 48.70 68.60	11 19.80 30.90 59.00
12 72.70 89.60 100.0	12 16.80 31.40 44.10	12 31.30 47.60 61.90	12 42.40 62.00 81.40	12 32.10 60.00 83.90	12 29.40 51.30 79.20

URM - MR	STL PERIM. MRF -MR	RCSW NO MRF - MR	MD RC MRF - MR	PC FRAME -MR	RM SW W/ MRF - MR
.9 .9 .82 1 1 1 1	.5 .5 .85 .7 .8 1 1	.6 .6 .8 .65 .91 .97 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .57 .83 .8 1	.35 .35 .9 .85 .91 .97 1
6 1.20 4.60 10.90	6 0.01 0.70 2.50	6 0.20 1.00 2.80	6 0.40 1.70 3.90	6 .001 1.10 4.90	6 0.60 1.40 2.90
7 2.60 11.40 31.30	7 0.70 2.10 5.10	7 0.60 3.70 7.80	7 2.50 5.10 14.80	7 1.10 3.40 10.10	7 1.60 3.50 8.00
8 12.70 28.80 55.00	8 1.60 4.40 9.80	8 3.30 8.80 16.10	8 5.70 13.00 25.70	8 3.30 8.40 21.60	8 3.70 8.80 16.80
9 28.80 51.40 77.30	9 4.30 8.90 15.80	9 8.00 17.50 29.50	9 13.70 26.50 45.50	9 10.50 27.20 34.50	9 8.10 15.20 27.20
10 45.80 71.70 94.80	10 8.00 15.70 24.60	10 16.40 28.90 44.70	10 21.40 35.70 58.00	10 24.20 43.10 62.90	10 13.00 23.70 45.00
11 62.00 83.00 98.30	11 12.00 28.20 40.30	11 22.60 39.50 57.90	11 33.50 51.90 74.20	11 29.30 53.70 78.30	11 22.80 39.40 69.40
12 74.90 91.10 100.0	12 17.10 36.40 51.10	12 33.10 49.80 70.40	12 47.80 67.40 92.60	12 35.70 68.70 93.70	12 37.00 57.80 87.50

TILT UP	STL PERIM. MRF -HR	RCSW NO MRF - HR	MD RC MRF - HR	PC FRAME - HR	RM SW W/ MRF - HR
.5 .5 .85 .68 .77 .7 1	.5 .5 .85 .7 .8 1 1	.6 .6 .8 .65 .91 .97 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .57 .83 .8 1	.35 .35 .9 .85 .91 .97 1
6 0.40 1.50 4.20	6 0.01 0.70 3.50	6 0.20 1.20 3.00	6 0.40 1.70 3.50	6 .001 1.10 5.00	6 0.80 1.60 3.20
7 1.80 4.20 9.60	7 0.90 2.40 7.30	7 1.00 5.60 10.90	7 1.70 5.40 13.40	7 1.00 4.10 9.80	7 1.20 2.90 7.10
8 4.00 10.60 18.20	8 2.30 6.20 14.20	8 4.10 11.80 21.40	8 6.00 13.30 28.00	8 3.30 10.10 24.60	8 3.10 7.10 14.80
9 9.10 18.50 31.60	9 5.30 14.50 24.50	9 10.50 24.80 39.00	9 12.60 25.30 44.90	9 11.90 29.60 39.70	9 6.80 13.20 25.20
10 15.20 28.70 49.20	10 9.60 19.80 31.50	10 26.10 37.70 57.70	10 23.70 40.50 65.20	10 24.70 44.30 63.90	10 11.20 24.30 47.40
11 25.60 45.00 69.40	11 17.00 36.70 50.50	11 36.90 54.00 75.00	11 33.70 55.30 80.30	11 29.90 54.60 79.60	11 19.40 40.10 69.70
12 35.60 62.50 80.20	12 23.40 44.50 59.10	12 48.30 67.10 88.20	12 54.00 75.80 94.90	12 35.00 69.70 99.50	12 36.00 66.50 89.90

BR STL FRAME -LR	STL DISTRIB MRF-LR	URM INFILL - LR	D RC MRF - LR	RM SW W/O MRF - LR	LONG SPAN
.53 .53 .85 .7 .91 .87 1	.5 .5 .85 .7 .8 1 1	.83 .83 .82 .78 .77 .85 1	.45 .45 .8 .65 .83 .97 1	.35 .35 .9 .85 .91 .97 1	1 1 .9 .7 .83 1 1
6 0.01 0.60 2.40	6 0.01 0.40 1.90	6 0.20 1.70 6.80	6 0.20 0.40 1.50	6 0.20 0.80 2.30	6 0.01 0.30 1.60
7 0.40 1.80 5.00	7 0.10 1.40 4.20	7 1.70 5.80 18.90	7 0.70 1.70 4.70	7 0.90 2.90 7.10	7 0.20 1.10 5.50
8 1.20 5.10 10.30	8 1.10 2.90 7.60	8 3.60 14.10 36.60	8 2.10 4.10 10.40	8 2.20 6.00 14.20	8 1.00 4.00 10.60
9 4.60 10.10 18.70	9 2.80 5.80 12.10	9 11.60 28.50 58.40	9 4.00 9.20 16.90	9 4.60 13.50 27.20	9 3.60 9.00 17.20
10 7.90 15.80 27.40	10 4.70 10.80 20.10	10 21.50 44.00 79.40	10 8.70 17.50 26.60	10 11.90 23.20 40.50	10 7.60 16.10 33.00
11 13.90 27.00 43.40	11 7.10 19.70 31.00	11 32.60 60.20 95.40	11 15.30 25.90 36.30	11 21.50 41.90 62.20	11 16.00 29.70 45.90
12 19.60 38.80 53.90	12 18.60 32.50 44.10	12 47.20 76.10 99.99	12 28.30 41.90 51.70	12 31.80 52.30 72.90	12 27.50 45.70 62.50

Figure B2

added to the Basic Structural Hazard scores above, (or subtracted, depending on whether their effect was to decrease or increase the probability of major damage) the resulting modified score would approximate the probability of major damage given the presence of that factor.

The final list of performance modification factors applicable to the rapid visual screening methodology is:

Poor condition: deterioration of structural materials

Plan irregularities: buildings with reentrant corners and long narrow wings such as L, H, or E-shaped buildings

Vertical irregularities: buildings with major cantilevers, major setbacks, or other structural features that would cause a significant change in stiffness in the upper stories of the building

Soft story: structural features that would result in a major decrease in the lateral load resisting system's stiffness at one floor - typically at the ground floor due to large openings or tall stories for commercial purposes

Pounding: inadequate seismic clearance between adjacent buildings - to be applied only when adjacent building floor heights differ so that building A's floors will impact building B's columns at locations away from B's floor levels and thus weaken the columns..

Large heavy cladding: precast concrete or stone panels that might be inadequately anchored to the outside of a building and thus cause a falling hazard (only applies to buildings designed prior to the adoption of the local ordinances requiring improved seismic anchorage).

Short columns: columns designed as having a full story height but which because of wall sections or deep spandrel beams between the columns have an effective height much less than the full story height. This causes brittle failure of the columns and potential collapse.

Torsion: corner or wedge buildings or any type of building in which the lateral load resisting system is highly non-symmetric or concentrated at some distance from the center of gravity of the building.

Soil profile: soil effects were treated by employing the UBC and NEHRP classification of "standard" soil profiles SL1, SL2 and SL3, where SL1 is rock, or stable soil deposits of sands, gravels or stiff clays less than 200 ft. in thickness; SL2 is deep cohesionless or stiff clay conditions exceeding 200 ft. in thickness; and SL3 is soft to medium stiff clays or sands, greater than 30 ft. in thickness. Present building code practice is to apply an increase in lateral load of 20% for SL2 profiles and 50% for SL3 profiles, over the basic design lateral load. This approach was used herein, and these factors were applied to the EPA for each NEHRP Map Area to determine the impact on the Basic Structural Hazard score. It was determined that this impact could generally be accounted for by a PMF of 0.3 for SL2 profiles, and 0.6 for SL3 profiles. Further, to account for resonance type effects, based on judgment the 0.6 PMF for SL3 profiles was increased to 0.8 if the building in questions was 8 to 20 stories in height.

Benchmark Year: year in which modern seismic design revisions were enforced by the local jurisdiction. Buildings built after this year are assumed to be seismically adequate unless exhibiting a major defect as discussed above.

Unbraced parapets, overhangs, chimneys and other non-structural falling hazards, while potentially posing life safety problems, do not cause structural collapse and therefore have not been assigned performance modifiers. Similarly, weak masonry foundations, unbraced cripple walls and houses not bolted to their foundations will cause significant structural damage but will probably not lead to structural collapse. Therefore the data collection form contains a section where this type of information may be noted, and the owner notified.

It was also determined that certain building types were not significantly affected by some of the factors. Therefore the modifiers do not apply to all building types. The actual values of the PMFs, specific to each NEHRP Map Area, may be seen on the data collection forms, Figures B3a,b,c.

ATC-21/ (NEHRP Map Areas 1,2 Low)	
Rapid Visual Screening of Seismically Hazardous Buildings	Address ________ Zip ________
	Other Identifiers ________
	No. Stories ________ Year Built ________
	Inspector ________ Date ________
	Total Floor Area (sq. ft) ________
	Building Name ________
	Use ________
	(Peel-off label)
Scale:	INSTANT PHOTO

OCCUPANCY

Residential	No. Persons
Commercial	0–10
Office	11–100
Industrial	100+
Pub. Assem.	
School	
Govt. Bldg.	
Emer. Serv.	
Historic Bldg.	

Non Structural Falling Hazard ☐

DATA CONFIDENCE

* = Estimated, Subjective, or Unreliable Data

DNK = Do Not Know

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	**8.5**	**3.5**	**2.5**	**6.5**	**4.5**	**4.0**	**4.0**	**3.0**	**3.5**	**2.5**	**4.0**	**2.5**
High Rise	N/A	0	0	N/A	-0.5	-0.5	-0.5	-0.5	N/A	-1.0	-1.5	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-1.0
Soft Story	-1.0	-2.0	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-1.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8
FINAL SCORE												

COMMENTS

Detailed Evaluation Required? YES NO

ATC12LOW
30032.01

Figure B3a

ATC-21/ (NEHRP Map Areas 3,4, Moderate)

Rapid Visual Screening of Seismically Hazardous Buildings

Address ____________________

____________________ Zip ________

Other Identifiers ____________________

No. Stories ____________ Year Built ________

Inspector ____________ Date ________

Total Floor Area (sq. ft) ____________________

Building Name ____________________

Use ____________________

(Peel-off label)

Scale:

INSTANT PHOTO

OCCUPANCY	
Residential	No. Persons
Commercial	0–10
Office	11–100
Industrial	100+
Pub. Assem.	
School	
Govt. Bldg.	
Emer. Serv.	
Historic Bldg.	

Non Structural Falling Hazard ☐

DATA CONFIDENCE

* = Estimated, Subjective, or Unreliable Data

DNK = Do Not Know

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	6.0	4.0	3.0	6.0	4.0	3.0	3.5	2.0	3.5	2.0	3.5	2.0
High Rise	N/A	-1.0	-0.5	N/A	-1.0	-0.5	-1.0	-1.0	N/A	0	-0.5	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-0.5	-1.0	-1.0	-1.0	-0.5	-1.0
Soft Story	-1.0	-2.0	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-1.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8
FINAL SCORE												

COMMENTS

ATC21ICMD
30000.01

Detailed Evaluation Required?

YES NO

Figure B3b

ATC-21/ (NEHRP Map Areas 5,6,7 High)

Rapid Visual Screening of Seismically Hazardous Buildings

Scale:

Address ______________________ Zip ______

Other Identifiers ______________________

No. Stories __________ Year Built __________

Inspector __________ Date __________

Total Floor Area (sq. ft) ______________________

Building Name ______________________

Use ______________________

(Peel-off label)

INSTANT PHOTO

OCCUPANCY

	No. Persons
Residential	0–10
Commercial	11–100
Office	100+
Industrial	
Pub. Assem.	
School	
Govt. Bldg.	
Emer. Serv.	
Historic Bldg.	

Non Structural Falling Hazard ☐

DATA CONFIDENCE

* = Estimated, Subjective, or Unreliable Data

DNK = Do Not Know

STRUCTURAL SCORES AND MODIFIERS

BUILDING TYPE	W	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	C1 (MRF)	C2 (SW)	C3/S5 (URM INF)	PC1 (TU)	PC2	RM	URM
Basic Score	**4.5**	**4.5**	**3.0**	**5.5**	**3.5**	**2.0**	**3.0**	**1.5**	**2.0**	**1.5**	**3.0**	**1.0**
High Rise	N/A	-2.0	-1.0	N/A	-1.0	-1.0	-1.0	-0.5	N/A	-0.5	-1.0	-0.5
Poor Condition	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Vert. Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-0.5	-0.5	-1.0	-1.0	-0.5	-0.5
Soft Story	-1.0	-2.5	-2.0	-1.0	-2.0	-2.0	-2.0	-1.0	-1.0	-2.0	-2.0	-1.0
Torsion	-1.0	-2.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-1.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-1.0	-1.0	-1.0	-1.0
Pounding	N/A	-0.5	-0.5	N/A	-0.5	-0.5	N/A	N/A	N/A	-0.5	N/A	N/A
Large Heavy Cladding	N/A	-2.0	N/A	N/A	N/A	-1.0	N/A	N/A	N/A	-1.0	N/A	N/A
Short Columns	N/A	N/A	N/A	N/A	N/A	-1.0	-1.0	-1.0	N/A	-1.0	N/A	N/A
Post Benchmark Year	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0	N/A	+2.0	+2.0	+2.0	N/A
SL2	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
SL3	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
SL3 & 8 to 20 stories	N/A	-0.8	-0.8	N/A	-0.8	-0.8	-0.8	-0.8	N/A	-0.8	-0.8	-0.8
FINAL SCORE												

COMMENTS

ATC874
30032.01

Detailed Evaluation Required?

YES NO

Figure B3c

REFERENCES

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APPENDIX C

CRITERIA FOR SELECTION OF A CUT-OFF SCORE

Because the final Structural Score S can be directly related to the probability of major damage, the field survey building S scores can be employed in an approximate cost-benefit analysis of costs of detailed review versus benefits of increased seismic safety, as a guide for selection of a cut-off S appropriate for a particular jurisdiction.

As a preliminary guide to an appropriate cut-off value of S, note that an S of 1 indicates a probability of major damage of 1 in 10, given the occurrence of ground motions equivalent to the Effective Peak Acceleration (EPA) for the particular NEHRP Map Area. S =2 corresponds to a probability of 1 in 100, S =3 is 1 in 1000, and so on.

As a simple example, take a jurisdiction with a population of 10,000 and a corresponding building inventory of 3,000 wood frame houses and 100 tilt-up, 100 LR URM, and 10 mid-rise steel-framed buildings. Assume the jurisdiction is in NEHRP Map Area 6, and the Basic Structural Hazard scores of Appendix B, High seismic area, apply. Assume for the example that no penalties apply (in actuality, the penalties of course would discriminate the good structures from the bad). The building inventories, probabilities of major damage and corresponding mean number of buildings sustaining major damage are shown in Table C1.

Table C1

Type	No. Bldgs.	S	Prob. Major Damage	Expected No. Bldgs. With Major Damage
Wood	3,000	4.5	1/31,600	Approx. 0
Tilt-up	100	2.0	1/100	Approx. 1
URM	100	1.0	1/10	Approx. 10
Br. Steel Fr.	100	3.0	1/1000	Approx. 0

Given these results, this example jurisdiction might decide that a cut-off S of between 1 and 2 is appropriate. A jurisdiction ten times larger (i.e., 100,000 population, everything else in proportion) in the same Map Area might decide that the potential life loss in a steel-framed mid-rise (1,000 mid-rise buildings instead of 10) warrants the cut-off S being between 2 and 3. Different cut-off S values for different building or occupancy types might be warranted.

Ideally, each community should engage in some consideration of the costs and benefits of seismic safety, and decide what S is an appropriate "cut-off" for their situation. Because this is not always possible, the observation that research has indicated (NBS, 1980; see references in Appendix B) that:

> "In selecting the target reliability it was decided, after carefully examining the resulting reliability indices for the many design situations, that $\beta = 3$ is a

> representative average value for many frequently used structural elements when they are subjected to gravity loading, while $\beta = 2.5$ and $\beta = 1.75$ are representative values for loads which include wind and earthquake, respectively".

(where β, the structural reliability index, as used in the National Bureau of Standards study, is approximately equivalent to S as used herein) is provided.

That is, present design practice is such that an S of about 3 is appropriate for day-to-day loadings, and a value of about 2 or somewhat less is appropriate for infrequent but possible earthquake loadings.

It is possible that communities may decide to assign a higher cut-off score for more important structures such as hospitals, fire and police stations and other buildings housing emergency services. However, social function has not been discussed in the development of the scoring system for this RSP. This will be addressed in a future FEMA publication tentatively entitled "Handbook for Establishing Priorities for Seismic Retrofit of Buildings." Until and unless a community considers the cost-benefit aspects of seismic safety for itself, a preliminary value to use in an RSP, would be an S of about 2.0.

APPENDIX D

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APPENDIX E

ATC PROJECT AND REPORT INFORMATION

One of the primary purposes of Applied Technology Council is to develop resource documents that translate and summarize research information into forms useful to practicing engineers. This includes the development of guidelines and manuals, as well as the development of research recommendations for specific areas determined by the profession. ATC is not a code development organization, although several of the ATC project reports serve as resource documents for the development of codes, standards and specifications.

A brief description of several major completed and ongoing projects is given in the following section. Funding for projects is obtained from government agencies and tax-deductible contributions from the private sector.

ATC-1: This project resulted in five papers which were published as part of *Building Practices for Disaster Mitigation*, Building Science Series 46, proceedings of a workshop sponsored by the National Science Foundation (NSF) and the National Bureau of Standards (NBS). Available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22151, as NTIS report No. COM-73-50188.

ATC-2: The report, *An Evaluation of a Response Spectrum Approach to Seismic Design of Buildings*, was funded by NSF and NBS and was conducted as part of the Cooperative Federal Program in Building Practices for Disaster Mitigation. Available through the ATC office. (270 pages)

> *Abstract*: This study evaluated the applicability and cost of the response spectrum approach to seismic analysis and design that was proposed by various segments of the engineering profession. Specific building designs, design procedures and parameter values were evaluated for future application. Eleven existing buildings of varying dimensions were redesigned according to the procedures.

ATC-3: The report, *Tentative Provisions for the Development of Seismic Regulations for Buildings* (ATC-3-06), was funded by NSF and NBS. The second printing of this report, which included proposed amendments, is available through the ATC office. (505 pages plus proposed amendments)

> *Abstract*: The tentative provisions in this document represent the result of a concerted effort by a multidisciplinary team of 85 nationally recognized experts in earthquake engineering. The project involved representation from all sections of the United States and had wide review by affected building industry and regulatory groups. The provisions embodied several new concepts that were significant departures from existing seismic design provisions. The second printing of this document contains proposed amendments prepared by a joint committee of the Building Seismic Safety Council (BSSC) and the NBS; the proposed amendments were published separately by BSSC and NBS in 1982.

ATC-3-2: The project, *Comparative Test Designs of Buildings Using ATC-3-06 Tentative Provisions*, was funded by NSF. The project consisted of a study to develop and plan a program for making comparative test designs of the ATC-3-06 Tentative Provisions. The project report was written to be used by the Building Seismic Safety Council in its refinement of the ATC-3-06 Tentative Provisions.

ATC-3-4: The report, *Redesign of Three Multistory Buildings: A Comparison Using ATC-3-06 and 1982 Uniform Building Code Design Provisions*, was published under a grant from NSF. Available through the ATC office (112 pages)

Abstract: This report evaluates the cost and technical impact of using the 1978 ATC-3-06 report, *Tentative Provisions for the Development of Seismic Regulations for Buildings*, as amended by a joint committee of the Building Seismic Safety Council and the National Bureau of Standards in 1982. The evaluations are based on studies of three existing California buildings redesigned in accordance with the ATC-3-06 Tentative Provisions and the 1982 Uniform Building Code. Included in the report are recommendations to code implementing bodies.

ATC-3-5: This project, *Assistance for First Phase of ATC-3-06 Trail Design Program Being Conducted by the Building Seismic Safety Council*, was funded by the Building Seismic Safety Council and provided the services of the ATC Senior Consultant and other ATC personnel to assist the BSSC in the conduct of the first phase of its Trial Design Program. The first phase provided for trial designs conducted for buildings in Los Angeles, Seattle, Phoenix, and Memphis.

ATC-3-6: This project, *Assistance for Second Phase of ATC-3-06 Trial Design Program Being Conducted by the Building Seismic Safety Council*, was funded by the Building Seismic Safety Council and provided the services of the ATC Senior Consultant and other ATC personnel to assist the BSSC in the conduct of the second phase of its Trial Design Program. The second phase provided for trial designs conducted for buildings in New York, Chicago, St. Louis, Charleston, and Fort Worth.

ATC-4: The report, *A Methodology for Seismic Design and Construction of Single-Family Dwellings*, was published under a contract with the Department of Housing and Urban Development (HUD). Available through HUD. 451 7th Street S.W., Washington, DC 20410, as Report No. HUD-PDR-248-1. (576 pages)

Abstract: This report presents the results of an in-depth effort to develop design and construction details for single-family residences that minimize the potential economic loss and life-loss risk associated with earthquakes. The report: (1) discusses the ways structures behave when subjected to seismic forces, (2) sets forth suggested design criteria for conventional layouts of dwellings constructed with conventional materials, (3) presents construction details that do not require the designer to perform analytical calculations, (4) suggests procedures for efficient plan-checking, and (5) presents recommendations including details and schedules for use in the field by construction personnel and building inspectors.

ATC-4-1: The report, *The Home Builders Guide for Earthquake Design* (June 1980), was published under a contract with HUD. Available through the ATC office. (57 pages)

Abstract: This report is a 57-page abridged version of the ATC-4 report. The concise, easily understood text of the Guide is supplemented with illustrations and 46 construction details. The details are provided to ensure that houses contain structural features which are properly positioned, dimensioned and constructed to resist earthquake forces. A brief description is included on how earthquake forces impact on houses and some precautionary constraints are given with respect to site selection and architectural designs.

ATC-5: The report, *Guidelines for Seismic*

Design and Construction of Single-Story Masonry Dwellings in Seismic Zone 2, was developed under a contract with HUD. Available through the ATC office.

Abstract: The report offers a concise methodology for the earthquake design and construction of single-story masonry dwellings in Seismic Zone 2 of the United States, as defined by the 1973 Uniform Building Code. The guidelines are based in part on shaking table tests of masonry construction conducted at the University of California at Berkeley Earthquake Engineering Research Center. The report is written in simple language and includes basic house plans, wall evaluations, detail drawings, and material specifications.

ATC-6: The report, *Seismic Design Guidelines for Highway Bridges*, was published under a contract with the Federal Highway Administration (FHWA). Available through the ATC office. (210 pages)

Abstract: The Guidelines are the recommendations of a team of sixteen nationally recognized experts that included consulting engineers, academics, state and federal agency representatives from throughout the United States. The Guidelines embody several new concepts that are significant departures from existing design provisions. An extensive commentary and an example demonstrating the use of the Guidelines are included. A draft of the Guidelines was used to seismically redesign 21 bridges and a summary of the redesigns is also included.

ATC-6-1: The report, *Proceedings of a Workshop on Earthquake Resistance of Highway Bridges*, was published under a grant from NSF. Available through the ATC office. (625 pages)

Abstract: The report includes 23 state-of-the-art and state-of-practice papers on earthquake resistance of highway bridges. Seven of the twenty-three papers were authored by participants from Japan, New Zealand and Portugal. The Proceedings also contain recommendations for future research that were developed by the 45 workshop participants.

ATC-6-2: The report, *Seismic Retrofitting Guidelines for Highway Bridges*, was published under a contract with FHWA. Available through the ATC office. (220 pages)

Abstract: The Guidelines are the recommendations of a team of thirteen nationally recognized experts that included consulting engineers, academics, state highway engineers, and federal agency representatives. The Guidelines, applicable for use in all parts of the U.S., include a preliminary screening procedure, methods for evaluating an existing bridge in detail, and potential retrofitting measures for the most common seismic deficiencies. Also included are special design requirements for various retrofitting measures.

ATC-7: The report, *Guidelines for the Design of Horizontal Wood Diaphragms*, was published under a grant from NSF. Available through the ATC office. (190 pages)

Abstract: Guidelines are presented for designing roof and floor systems so these can function as horizontal diaphragms in a lateral force resisting system. Analytical procedures, connection details and design examples are included in the Guidelines.

ATC-7-1: The report, *Proceedings of a Workshop on Design of Horizontal Wood Diaphragms*, was published under a grant from NSF. Available through the ATC office. (302 pages)

Abstract: The report includes seven papers on state-of-the practice and two papers on recent research. Also included are recommendations for future research that were developed by the 35 participants.

ATC-8: This project, *Workshop on the Design of Prefabricated Concrete Buildings for Earthquake Loads*, was funded by NSF. Project report available through the ATC office. (400 pages)

Abstract: The report includes eighteen state-of-the-art papers and six summary papers. Also included are recommendations for future research that were developed by the 43 workshop participants.

ATC-9: The report, *An Evaluation of the Imperial County Services Building Earthquake Response and Associated Damage*, was published under a grant from NSF. Available through the ATC Office. (231 pages)

Abstract: The report presents the results of an in-depth evaluation of the Imperial County Services Building, a 6-story reinforced concrete frame and shear wall building severely damaged by the October 15, 1979 Imperial Valley, California, earthquake. The report contains a review and evaluation of earthquake damage to the building; a review and evaluation of the seismic design; a comparison of the requirements of various building codes as they relate to the building; and conclusions and recommendations pertaining to future building code provisions and future research needs.

ATC-10: This report, *An Investigation of the Correlation Between Earthquake Ground Motion and Building Performance*, was funded by the U.S. Geological Survey. Available through the ATC office. (114 pages)

Abstract: The report contains an in-depth analytical evaluation of the ultimate or limit capacity of selected representative building framing types, a discussion of the factors affecting the seismic performance of buildings, and a summary and comparison of seismic design and seismic risk parameters currently in widespread use.

ATC-10-1: This report, *Critical Aspects of Earthquake Ground Motion and Building Damage Potential*, was co-funded by the USGS and the NSF. Available through the ATC office. (259 pages)

Abstract: This document contains 19 state-of-the-art papers on ground motion, structural response, and structural design issues presented by prominent engineers and earth scientists in an ATC seminar. The main theme of the papers is to identify the critical aspects of ground motion and building performance that should be considered in building design but currently are not. The report also contains conclusions and recommendations of working groups convened after the Seminar.

ATC-11: The report, *Seismic Resistance of Reinforced Concrete Shear Walls and Frame Joints: Implications of Recent Research for Design Engineers*, was published under a grant from NSF. Available through the ATC office. (184 pages)

Abstract: This document presents the results of an in-depth review and synthesis of research reports pertaining to cyclic loading of reinforced concrete shear walls and cyclic loading of joints in reinforced concrete frames. More than 125 research reports published since 1971 are reviewed and evaluated in this report, which was prepared via a consensus process that involved numerous experienced design professionals from throughout the U.S. The report contains reviews of current and past design practices, summaries of research developments, and in-depth discussions of design implications of recent research results.

ATC-12: This report, *Comparison of United States and New Zealand Seismic Design Practices for Highway Bridges*, was published under a grant from NSF. Available through the ATC office (270 pages).

Abstract: The report contains summaries of all aspects and innovative design procedures used in New Zealand as well as comparisons of United States and New Zealand design practice. Also included are research recommendations developed at a 3-day workshop in New Zealand attended by 16 U.S. and 35 New Zealand bridge design engineers and researchers.

ATC-12-1: This report, *Proceedings of Second Joint U.S.-New Zealand Workshop on Seismic Resistance of Highway Bridges*, was published under a grant from NSF. Available through the ATC office (272 pages).

Abstract: This report contains written versions of the papers presented at this 1985 Workshop as well as a list and prioritization of workshop recommendations. Included are summaries of research projects currently being conducted in both countries as well as state-of-the-practice papers on various aspects of design practice. Topics discussed include bridge design philosophy and loadings, design of columns, footings, piles, abutments and retaining structures, geotechnical aspects of foundation design, seismic analysis techniques, seismic retrofitting, case studies using base isolation, strong-motion data acquisition and interpretation, and testing of bridge components and bridge systems.

ATC-13: The report, *Earthquake Damage Evaluation Data for California*, was developed under a contract with the Federal Emergency Management Agency (FEMA). Available through the ATC office (492 pages).

Abstract: This report presents expert-opinion earthquake damage and loss estimates for existing industrial, commercial, residential, utility and transportation facilities in California. Included are damage probability matrices for 78 classes of structures and estimates of time required to restore damaged facilities to pre-earthquake usability. The report also describes the inventory information essential for estimating economic losses and the methodology used to develop the required data.

ATC-14: The report, *Evaluating the Seismic Resistance of Existing Buildings*, was developed under a grant from the National Science Foundation. Available through the ATC office (370 pages).

Abstract: This report, written for practicing structural engineers, describes a methodology for performing preliminary and detailed building seismic evaluations. The report contains a state-of-practice review; seismic loading criteria; data collection procedures; a detailed description of the building classification system; preliminary and detailed analysis procedures; and example case studies, including non-structural considerations.

ATC-15: This report, *Comparison of Seismic Design Practices in the United States and Japan*, was published under a grant from NSF. Available through the ATC office (317 pages).

Abstract: The report contains detailed technical papers describing current design practices in the United States and Japan as well as recommendations emanating from a joint U.S.-Japan workshop held in Hawaii in March, 1984. Included are detailed descriptions of new seismic design methods for buildings in Japan and case studies of the design of specific buildings (in both countries). The report also contains an overview of the history and objectives of the Japan Structural Consultants Association.

ATC-15-1: The report, *Proceedings of Second U.S.-Japan Workshop on Improvement of Building Seismic Design and Construction Practices*, was published under a grant from NSF. Available through ATC office (412 pages).

> *Abstract:* This report contains 23 technical papers presented at this San Francisco workshop in August of 1986 by practitioners and researchers from the U.S. and Japan. Included are state-of-the-practice papers and case studies of actual building designs and information on regulatory, contractual, and licensing issues.

ATC-16: This project, *Development of a 5-Year Plan for Reducing the Earthquake Hazards Posed by Existing Nonfederal Buildings*, was funded by FEMA and was conducted by a joint venture of ATC, the Building Seismic Safety Council and the Earthquake Engineering Research Institute. The project involved a workshop in Phoenix, Arizona, where approximately 50 earthquake specialists met to identify the major tasks and goals for a 5-year plan for reducing the earthquake hazards posed by existing nonfederal buildings nationwide. The plan was developed on the basis of nine issue papers presented at the workshop and workshop working group discussions. The Workshop Proceedings and Five-Year Plan are available through the Federal Emergency Management Agency, 500 "C" Street, S. W., Washington, D.C. 20472.

ATC-17: This report, *Proceedings of a Seminar and Workshop on Base Isolation and Passive Energy Dissipation*, was published under a grant from NSF. Available through the ATC office (478 pages).

> *Abstract*: The report contains 42 papers describing the state-of-the-art and state-of-the-practice in base-isolation and passive energy-dissipation technology. Included are papers describing case studies in the Untied States, applications and developments worldwide, recent innovations in technology development, and structural and ground motion design issues. Also included is a proposed 5-year research agenda that addresses the following specific issues: (1) strong ground motion; (2) design criteria; (3) materials, quality control, and long-term reliability; (4) life cycle cost methodology; and (5) system response.

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